Biological Assessment for

USDA Forest Service (Pacific Northwest Region),
USDI Bureau of Land Management (Oregon State Office)
and the Bureau of Indian Affairs

Fish Habitat Restoration Activities Affecting ESA-Listed Animal and Plant Species and their Designated or Proposed Critical Habitat and Designated Essential Fish Habitat under MSA found in Oregon, Washington and parts of California, Idaho and Nevada

Prepared by

USDA Forest Service (Pacific Northwest Region),
Bureau of Land Management (Oregon State Office)
and the Bureau of Indian Affairs

In Partnership with

US Fish and Wildlife Service
and
NOAA Fisheries

Submitted to

US Fish and Wildlife Service
and
NOAA Fisheries

January 28, 2013

Table of Contents

I. Introduction

This Aquatic Restoration Biological Assessment II (ARBA II) includes a number of individual actions that, when grouped together, represent programs that may occur at many individual sites across Bureau of Land Management (BLM), U.S. Forest Service (FS), and adjacent lands in Washington and Oregon. The Coquille Indian Tribe lands are included under the ARBA II and will be represented by the Bureau of Indian Affairs (BIA). The Coquille Indian Tribe is included in this ARBA II as they are the only Tribal signatory to the Northwest Forest Plan.

The ARBA II actions can occur on a routine basis or sporadically and over an indefinite period, starting in 2013. This programmatic approach provides each BLM, FS and BIA administrative unit with a consistent methodology to design, implement, monitor, and document aquatic restoration activities. In addition, the ARBA II facilitates Endangered Species Act (ESA) Section 7 and Magnuson/Stevens Act (MSA) consultation or conference with the NOAA Fisheries (from hereafter referred to as the National Marine Fisheries Service [NMFS]) and ESA Section 7 consultation with the U.S. Fish and Wildlife Service (FWS). The ARBA II also provides information in sufficient detail and quality to support an NMFS and FWS analysis.

All proposed activity categories comply with the Record of Decision and Standards and Guidelines of the Northwest Forest Plan (USDA and USDI 1994), INFISH (USDA and USDI 1995a), PACFISH (USDA and USDI 1995b), and respective BLM Resource Management Plans and FS Land and Resource Management Plans.

The ARBA II is intended to include those aquatic restoration activities that are implemented on lands under the jurisdiction of the BLM, FS and BIA wherever ESA- and MSA-listed species are found. The activities are predictable as to their effects to ESA- and MSA- listed species and consistent with broad-scale aquatic conservation strategies and the best available science. This consultation may include those actions, such as Sudden Oak Death treatments, that have limited application and are only applicable to a limited number of administrative units. Further, new activities not covered in this ARBA II can be added to the subsequent ARBO II by amendment as long as the effects and outcomes of such actions are consistent with those described in ARBA II. Projects that are inconsistent with outcomes and/or effects described in this ARBA II are not eligible for inclusion by amendment and will require a separate consultation.

Aquatic restoration activities included in this ARBA II are considered to be Likely Adversely Affect (LAA) to ESA-listed fish species and designated or proposed Critical Habitat and May Adversely Affect (MAA) MSA Essential Fish Habitat. The BLM, FS and BIA request a conference using the formal consultation procedures with NMFS for proposed critical habitat designations under ESA, and a consultation under MSA with NMFS on the effects to Essential Fish Habitat for the entire ARBA II geographic area, including areas currently without ESA-listed fish, where Chinook, coho, and pink salmon are present.

Administrative units that already have a biological opinion covering aquatic restoration activities should continue to use those documents until their coverage expires and then begin using this programmatic consultation. Aquatic restoration actions not covered in this ARBA II can be covered in new local or provincial biological assessments (BA). However, to prevent BA duplication for Oregon and Washington BLM and FS administrative units, future local or provincial BAs should not include actions and associated project design criteria covered in the ARBA II. Further, invasive plant treatments included in this ARBA II are to serve BLM, FS and BIA administrative units until such units complete a local or provincial consultation for this activity type.

A. Background

During the early to mid-1990's, the BLM and FS took assertive steps to better protect fish habitat and address dwindling salmon, trout, and other native fish stocks in Oregon and Washington. In doing so, the FS amended National Forest Land and Resource Management Plans and the BLM amended Land Management Plans with one or more the of the following conservation strategies: Northwest Forest Plan (NWFP) (USDA and USDI 1994), INFISH (USDA and USDI 1995a), and PACFISH (USDA and USDI 1995b).

A common element in these plans is to protect existing and restore former old-growth forest types throughout the plan areas, in part, to promote recovery of old-growth dependent species, such as the Northern Spotted Owl and Marbled murrelet. Another common element is an aquatic conservation strategy (ACS), providing a framework for the protection and restoration of fish stocks and water quality by maintaining and restoring watershed processes under which fish populations are uniquely adapted. Watershed processes as outlined in the NWFP, PACFISH, and INFISH include the following: sediment, hydrologic and thermal regimes; organic inputs; nutrient cycling; aquatic habitat integrity; upland/riparian vegetation and aquatic biota assemblages. Further, the ACS is comprised of four basic elements—riparian reserves, key watersheds, watershed analysis, and watershed restoration. These four elements are designed to work in concert to maintain and restore the aforementioned watershed processes that support productive and resilient aquatic systems.

1. **Riparian Reserves** (RR) adopted under the NWFP and **Riparian Habitat Conservation Areas** (RHCA) implemented under INFISH and PACFISH are those portions of BLM, FS, and BIA lands where riparian dependent resources receive primary emphasis. Riparian Reserves and RHCAs include those land areas in the watershed directly adjacent to streams and rivers, places required for maintaining hydrologic, geomorphic, and ecological processes that directly affect standing and flowing water bodies (USDA and USDI 1994). These riparian habitats help maintain the integrity of the aquatic ecosystems by a) influencing the delivery of coarse sediment, organic matter, and woody debris to streams; b) providing root strength for channel stability; c) shading the stream; and d) protecting water quality (USDA and USDI 1995a). To maintain the integrity of RR and RHCAs, which vary from 50 to 500 feet on either side of a water body, all management activities in these areas are guided by standards and guides, which prohibit or regulate activities that retard or prevent the attainment of riparian functions. Thus, these protective measures apply to the 90,000 stream miles on FS lands—of which 24,000 are fish bearing—and 10,000 miles of fish-bearing streams on BLM lands.
2. **Key or Priority Watersheds** are a network of watersheds on BLM and FS lands in Oregon and Washington that serve as refuges for salmon and other fish species, many of which are listed under the ESA. Watersheds in good condition serve as anchors for potential recovery of depressed fish stocks, while watersheds characterized by having low quality habitat and high potential for restoration can serve as future refuge areas (USDA and USDI 1994). In Oregon and Washington, there are 139 Key Watersheds located throughout the NWFP. Under INFISH, priority watersheds were designated, in part, to protect watersheds with excellent habitat, especially for bull trout and metapopulation objectives (USDA and USDI 1995a). Key or Priority watersheds have been the primary target for watershed analysis and restoration.

3. **Watershed Analysis** is a means to diagnose the health of a watershed, especially Key and Priority watersheds, and documents the root causes of degradation to those ecosystem processes that create quality habitat and water quality through time. Since 1994, approximately 350 watershed analyses have been completed by National Forests and BLM Districts in Oregon and Washington. The documents identify factors limiting fish production and associated restoration actions.
4. **Watershed Restoration** is a program, based on watershed analysis and resulting watershed restoration action plans (WRAPS) or equivalent prioritization strategies, that helps restore a watershed's hydrological and ecological processes that are necessary to ensuring the long-term recovery of fish populations and water quality. WRAPs continue to be completed or revised for high priority sub-watersheds and include the following: prioritized list of projects to address degraded watershed processes, cost estimates, expected date of completion of all projects, projected outcomes. Projects are implemented from valley bottoms to ridge tops: in-channel projects (i.e., large wood placement, channel reconstruction, and fish passage restoration at road crossings); floodplain and riparian areas (i.e., levee removal, conifer or hardwood protection and thinning, and road treatments); uplands (i.e., conifer thinning, controlled burning, and road treatments).

Since implementation of the NWFP, PACFISH, and INFISH, the BLM, FS and BIA have transitioned from conducting aquatic restoration from an opportunistic, single-project approach to a strategic focus that addresses anthropogenic disruptions of ecosystem processes at the watershed scale. A prime example of the way in which this transition has occurred can be found in the Steamboat and Jackson Creek watersheds, tributary systems to the Umpqua River on the Umpqua National Forest.

In the 1960s and 70s, large wood was removed from Steamboat and Jackson creeks and their tributaries to promote fish passage by bucking in-stream logs into 6' pieces, small enough to flush-out during high-flow events. During the 1970s and 80s, rock gabions, constructed with wire mesh, were installed on bedrock stream reaches (probably created through wood removal) to capture gravel. The late 1980s ushered in projects that reintroduced wood into streams, whereby wood, often too small to withstand flows, was anchored to bedrock with wire cable. These pre NWFP, PACFISH, and INFISH projects were still evident in the watersheds during the early 2000's (Scott Peets pers. comm. 2012), were installed to treat symptoms of degradation but were out of sync with local watershed process and biological potential.

After the NWFP, PACFISH, and INFISH ushered in a new aquatic restoration paradigm, action agencies were directed to address root causes of degradation to restore ecological processes. Therefore, the Umpqua National Forest conducted watershed assessments and developed WRAPS for the Steamboat and Jackson watersheds, Key Watersheds under the NWFP. Restoration actions were designed and implemented to address anthropogenic disruptions (riparian timber harvest, road construction, stream cleaning) to ecological processes. In the late 1990s, the Forest began placing substantial amounts of large wood (>25" dbh and 50' long) in watershed streams via helicopter, mimicking debris flows/jams and wind-throw, watershed process that were disrupted by past timber harvests. Such projects will continue until young tree stands in riparian areas grow large enough to produce natural inputs of in-stream wood. These projects were accompanied by other actions, such as fish-passage culvert projects, road decommissioning, and conifer thinning in plantations.

Similar pre and post NWFP, PACFISH, and INFISH examples can be found on every national forest and BLM district in Oregon and Washington. Even still, the action agencies continue to refine the way in which the ACS is implemented to accommodate new science and recovery needs. For instance, in the Key/Priority watersheds, the BLM and FS have and continue to prioritize the sub-watersheds (6^{th} HUC) for restoration. Rating criteria often include the following: number of ESA-listed fish species; importance of sub-watersheds to fulfill life history requirements; types and extent of degradation; habitat and water quality conditions; connection to fish and water quality recovery plans; potential for restoration. In addition, the geographic distribution of Key Watersheds may not fully accommodate the recovery needs of all ESA-listed fish species. As a result, high-priority 6^{th} field sub-watersheds outside of designated Key Watersheds have been identified. These areas are of critical importance to several ESA-listed fish species but would otherwise not be considered as high priorities for restorative actions.

Aquatic restoration guidance in the NWFP, PACFISH, and INFISH has stood the test of time and remains consistent with current watershed restoration concepts, such as those described in the article *Processed-based Principles for Restoring River Ecosystems* (Beechie et. al. 2010). The article summarizes contemporary knowledge of process-based restoration and offers four process-based principles to guide aquatic restoration: 1) target root causes of habitat and ecosystem degradation; 2) tailor restoration actions to local potential; 3) match the scale of restoration to the scale of physical and biological processes; 4) be explicit about the expected outcomes, including recovery. In regards to principle 4, recovery of watershed processes could be partial or complete (Reeves et al. 1995; Beechie et al. 2010), depending on numerous variables, such as social and technological constraints.

The BLM and FS WRAPs are based on these process-based principles and an assumption that complete restoration of a watershed is often socially, economically, and/or politically impossible because road systems and other infrastructure will remain intact due to public demands. Therefore, the removal of all disruptions and returning an entire landscape to a natural disturbance regime is not possible for most watersheds. Consequently, WRAP projects strategically address anthropogenic disruptions that are not precluded by social, economic, and/or political constraints. As such, disruptions can be eliminated (e.g., road decommissioning) or modified (e.g., culvert replacement) to better accommodate natural processes at the reach or watershed scale.

Once WRAP actions are completed, a sub-watershed will be transformed into one that has been moved closer to a natural, reference condition. Over time, however, economic, social, and/or political constraints may go away, allowing additional projects to be implemented and moving the watershed even closer to natural, reference conditions. From there, action agencies will direct efforts to complete additional WRAPs in other priority watersheds with an ultimate objective of creating a network of restored watersheds throughout evolutionary significant units (ESU), distinct population segments (DPS), or interim recovery units (IRU).

Thus, WRAPs have and continue to serve as the primary means to deliver scarce resources to priority watersheds for the restoration of fish stocks and water quality. Prior to the ARBO, many BLM and FS and administrative units could not efficiently implement WRAP projects due to an inability to acquire biological opinions (BO). Before 2007, for instance, 58% of the BLM and FS administrative units in Oregon and Washington with ESA-listed salmon or steelhead species had NMFS programmatic BOs for aquatic restoration. The BIA, the only tribe that adopted the NWFP, shared a NMFS biological opinion with BLM and FS administrative units in southwest

Oregon. Approximately 33% of the BLM and FS administrative units with ESA-listed resident fish species had FWS programmatic BOs for aquatic restoration. The BLM and FS units that acquired programmatic BOs secured predictability for out-year planning as well as a reduction in planning time and costs, creating savings that were directed to leveraging partner funds for project implementation. Those units without programmatic coverage, however, were often discouraged from pursuing restoration projects due to the time and funds required for individual consultations. Thus, a restoration gap existed between those units that had programmatic consultations and those that did not.

To address this restoration gap and expedite the implementation of recovery-oriented WRAPs on all BLM and FS lands in Oregon and Washington, the Regional Interagency Executives Committee issued a December 10, 2004 memorandum that recommended the development of a new program-level fish habitat restoration consultation for the BLM and FS. Consequently, an ARBA was developed and submitted in 2006, and the FWS and NMFS ARBOs (hereinafter referred to as ARBO) were issued in 2007. Since 2007, all BLM and FS administrative units in Oregon and Washington and the BIA received coverage under the ARBO. Refer to Tables 1 and 2 for ARBO accomplishments.

For the first time since species occupying habitat on Federal lands were listed under the ESA, the ARBO provided coverage to 100% of the BLM and FS units in Oregon and Washington for aquatic restoration. This alone provided an opportunity to more BLM and FS units to pursue restoration because of reduced cost and time requirements.   The newly covered BLM and FS units followed the success of their predecessors by leveraging saved resources with partners to implement WRAP projects. For instance, estimates for the FS alone suggest a savings of ~7,000 person-days and $2.5 million through streamlined consultation requirements from 2007-2012. With predictability of out-year planning along with cost and time savings, demand for aquatic restoration projects on BLM/FS annual work plans have increased. Finally, the ARBO brought a unified approach to identifying programmatic activity categories, project design criteria, and reporting within and amongst action agencies, resulting in improved communication and project implementation. The current ARBO is due to expire on December 31, 2012.

Table 1 - ARBO Accomplishments from 2008-2011

Year	In-channel Projects		Fish Pasage Projects		Estuary Projects		Roads Treated		Vegetation Treated	
	# projects	miles treated	# projects	miles opened	# project	acres treated	# projects	miles treated	# projects	acres treated
2008	52	104	31	62	0	0	13	28	26	1,525
2009	75	126	22	29	2	62	13	23	12	5,751
2010	102	121	59	107	0	0	32	277	25	680
2011	94	132	56	44	1	50	19	172	6	12,092
Totals	**323**	**483**	**168**	**242**	**3**	**112**	**77**	**500**	**69**	**20048**

Table 2: ARBO Accomplishments applied to Recovery Domains and IRU for 2008-2011*

NMFS Recovery Domain and USFWS IRU	In-channel Projects**		Fish Passage Projects***				Estuary Projects				Roads Treated		Vegetation Treated	
	# projects	miles treated	# projects	miles opened	Take Handled/Mort		# Proejcts	Acres	Take Handled/Mort		# projects	miles treated	# projects	acres treated
Recovery Domain														
Puget Sound	9	12	3	2	420	0	0	0	0	0	18	52	1	10
Willamette-Lower Columbia	78	126	21	17	85	0	0	0	0	0	37	248	6	710
Interior Columbia	38	33	46	73	467	1	0	0	0	0	15	19	13	18300
Oregon Coast	153	256	88	92	1337	4	3	112	34	34	1	2	33	195
Southern Oregon/Northern California Coasts	45	56	10	15	0	0	0	0	0	0	4	178	16	433
Totals	323	483	168	199	2309	5	3	112	34	34	75	499	69	19648
IRU														
Columbia (includes Columbia Basin, Puget Sound and Klamath River)	127	173	74	135	552	6	0	0	0	0	71	320	49	19020
Warner Basin	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Southeast Oregon Basins	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	127	173	74	135	552	6	0	0	0	0	71	320	49	19020

* Accomplishment numbers for Recovery Domains and DPS units are close approximates

** In-Channel Projects include the following: Large Wood, Boulder, and Gravel Placement; Reconnection of Existing Side Channels and Alcoves; Head-cut Stabilization and Associated Fish Passage; Irrigation Screen Installation and Replacement; Floodplain Overburden Removal; Reduction of Recreation Impacts; Removal of Legacy Structures; In-channel Nutrient Enhancement.

*** Fish Passage Projects include culvert and bridge replacements or removals.

B. ARBA II Activity Categories

The 20 ARBA II aquatic restoration activities will maintain, enhance and/or restore watershed processes that affect aquatic species and water quality. This ARBA II is intended to include those aquatic restoration activities that are implemented on lands under the jurisdiction of the BLM, FS and BIA, are predictable as to their effects to ESA- and MSA-listed species, and are consistent with broad scale aquatic conservation strategies and the best available science. For project descriptions, administration requirements, conservation measures, and project design criteria, refer to Chapter II.

1. Fish Passage Restoration (Stream Simulation Culvert and Bridge Projects; Headcut and Grade Stabilization; Fish Ladders; Irrigation Diversion Replacement/Relocation & Screen Installation/Replacement.)
2. Large Wood, Boulder, and Gravel Placement (Large Wood and Boulder Projects; Engineered Logjams; Porous Boulder Weirs and Veins; Gravel Augmentation; Tree Removal for Large Wood Projects)
3. Dam, Tidegate, and Legacy Structure Removal
4. Channel Reconstruction/Relocation
5. Off- and Side-Channel Habitat Restoration
6. Streambank Restoration
7. Set-back or Removal of Existing Berms, Dikes, and Levees
8. Reduction/Relocation of Recreation Impacts
9. Livestock Fencing, Stream Crossings, and Off-Channel Livestock Watering
10. Piling and other Structure Removal
11. In-channel Nutrient Enhancement
12. Road and Trail Erosion Control and Decommissioning
13. Non-native Invasive Plant Control
14. Juniper Removal
15. Riparian Vegetation Treatment (controlled burning)
16. Riparian Vegetative Planting
17. Bull Trout Protection
18. Beaver Habitat Restoration
19. Sudden Oak Death Treatments
20. Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration

Table 3 demonstrates the way ARBA II restoration activity categories address watershed-scale processes that control delivery of sediment, water, organic matter, nutrient and chemicals, light and heat, and biota from the surrounding environment into floodplains and stream channels. Table 4 demonstrates the way ARBA II restoration activity categories address reach-scale processes where floodplains and channels rework watershed-scale inputs to determine local habitat structure, water quality, and biotic assemblages in context of natural disturbance regimes.

Table 3 – Connection of ARBA II Aquatic Restoration Activity Categories to Processed-based Restoration at the Watershed Scale.				
Ecosystem Features (Beechie et al. 2010)	**Natural Driving Processes (Beechie et al. 2010)**	**Action Agency Recognition of and Direction in addressing Ecological Processes (Driving Processes) (USDA and USDI 1994)**	**Examples of Anthropogenic Disruptions**	***ARBA II Activity Category to address Disruptions**
Sediment	Sediment delivered to river systems through land sliding, surface erosion, and soil creep.	Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	Road Networks; Dams; Altered Fire Regime (juniper expansion); Past Silvicultural Practices; Livestock Grazing	3, 12, 13, 14, 15
Hydrology	Runoff delivered to streams through surface and subsurface flow paths.	Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	Road Networks; Dams; Floodplain Constrictions; Altered Fire Regime); Past Silvicultural Practices;	3, 12, 13, 14, 15
Organic Matter	Tree fall and leaf litter fall.	Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.	Road Networks; Floodplain Constrictions; Altered Fire Regime (eastside juniper);Past Silvicultural Practices; Livestock Grazing; Invasive Plant Introduction	3, 9, 12, 13, 14, 15
Light and Heat	Solar insolation and advective heat transfer to the water column.	Maintain and restore species composition and structural diversity of riparian plant communities to provide summer and winter thermal regulation.	Road Networks: Past Silvicultural Practices	3, 9, 12, 13, 14, 16
Nutrients	Delivery of dissolved nutrients via groundwater flow.	Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing.	Road Networks; Floodplain Constrictions;	3, 4, 5, 11
Biota	Migration of aquatic organisms, seed transport	Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian species.	Road Networks with undersized culverts block fish migration, serve as invasive plant vectors; Dams; Levees; Altered Fire Regime	1, 3, 12, 13, 14, 15, 17

*** ARBA II Activity Categories: 1.** Fish Passage Restoration; **2** Large Wood, Boulder, and Gravel Placement; **3.** Water Control, Legacy Habitat, and other Structure Removal; **4**. Channel Reconstruction/Relocation; **5.** Off- and Side-Channel Habitat Restoration; **6.** Streambank Restoration; **7.** Set-back or Removal of Existing Berms, Dikes, and Levees; **8.** Reduction/Relocation of Recreation Impacts; **9.** Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering; **10.** Piling Removal; **11.** In-channel Nutrient Enhancement; **12.** Road and Trail Erosion Control and Decommissioning; **13.** Invasive and Non-Native Plant Control; **14.** Juniper Removal; **15.** Riparian Vegetation Treatment (controlled burning); **16.** Riparian Vegetation Planting; **17.** Bull trout Protection; **18.** Beaver Habitat Restoration; **19.** Sudden Oak Death Treatments; **20.** Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration.

Table 4 – Connection of ARBA II Aquatic Restoration Activity Categories to Processed-based Restoration at the Reach Scale (channel and floodplain).

Ecosystem Features	Natural Driving Processes (Beechie et al. 2010)	Action Agency Recognition of and Direction in addressing Ecological Processes (Driving Processes) (USDA and USDI 1994)	Examples of Anthropogenic Disruptions	*ARBA II Activity Category to address Reach-scale Disruptions
Channel Morphology & Habitat Structure	Channel migration, bank erosion, bar formation, and floodplain sediment deposition create dynamic channel and floodplain environments. Sediment and wood transport and storage processes drive channel cross-section shape, formation of pools. Bank armoring via roots reduces bank erosion and narrow and deepen channels. Animals such as beaver modify the environment.	Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations. Maintain and restore species composition and structural diversity of riparian plant communities to provide for channel migration and amounts and distributions of woody debris to sustain physical complexity and stability.	Riparian Roads confine channels, restrict floodplains; Mine Tailings/Levies/Berms confine channels, restrict floodplains Under-sized Culverts promote scour, headcutting; Dams/Irrigation Weirs Legacy Restoration Structures that work against natural potential; Beaver Control.	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 14, 15, 16, 18, 19
Thermal Regime	Local stream shading and exchange of water between surface and hyporheic flows regulates stream temperature at the scale of habitat units and reaches.	Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation…	Riparian Roads reduce hyporheic flow and riparian vegetation; Beaver Control reduces hyporheic flow; Past Silvicultural Practices created even-aged monocultures; Altered Fire Regimes.	2, 3, 4, 5, 6, 7, 8, 9, 12, 14, 15, 16, 18, 19
Water Chemistry	Delivery of dissolved nutrients through groundwater and hyporheic exchange; uptake of nutrients by aquatic and riparian plants.	Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of nutrient, routing.	Dams, Irrigation Weirs, Levees.	2, 3, 4, 5, 6, 7, 9, 11, 12, 18
Riparian Vegetation Species Assemblages	Seedling establishment/colonization; Tree growth and succession drive reach-scale riparian plant assemblages.	Maintain and restore species composition and structural diversity of riparian plant communities to provide summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of woody debris to sustain physical complexity and stability.	Altered Fire Regime; Beaver Trapping/Control; Past & Current Silvicultural Practices; Past & Current livestock Grazing Practices; Invasive Weed Colonization and Succession.	2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 18, 19
Aquatic Species Assemblages	Photosynthesis drives primary production of algae and aquatic plants. Leaf-litter drive detritus based food web. Habitat selection, predation, feeding, growth, and competition drive species assemblages.	Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.	Under-sized culverts, irrigation weirs, and dams disrupt migration patterns.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13,14, 15, 16, 18, 19

ARBA II Activity Categories: 1. Fish Passage Restoration; **2** Large Wood, Boulder, and Gravel Placement; **3.** Water Control, Legacy Habitat, and other Structure Removal; **4** Channel Reconstruction/Relocation; **5.** Off- and Side-Channel Habitat Restoration; **6.** Streambank Restoration; **7.** Set-back or Removal of Existing Berms, Dikes, and Levees; **8.** Reduction/Relocation of Recreation Impacts; **9.** Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering; **10.** Piling Removal; **11.** In-channel Nutrient Enhancement; **12.** Road and Trail Erosion Control and Decommissioning; **13.** Invasive and Non-Native Plant Control; **14.** Juniper Removal; **15.** Riparian Vegetation Treatment (controlled burning); **16.** Riparian Vegetation Planting; **17.** Bull trout Protection; **18.** Beaver Habitat Restoration; **19.** Sudden Oak Death Treatments; **20.** Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration.

C. ARBA II Geographic Scope

This ARBA II covers those portions of Oregon and Washington wherever BLM, FS and BIA administrative units are found. It also covers portions of administrative units that are primarily located in Oregon and Washington but overlap into California (Rogue/Siskiyou NF), Nevada (Lakeview and Vale BLM District) and Idaho (Wallow Whitman NF). Refer to Figure 1.

Figure 1 – Geographic Scope of ARBA II

D. ARBA II Projects on Non-Federal Lands

Projects that occur on non-federal lands are included under this consultation when a project directly assists the BLM and/or FS in achieving their aquatic restoration goals and the BLM and/or FS contributes resources (funds, materials, planning, etc.) to the project. The BLM and FS are permitted to fund such projects under Wyden Amendment authority (16 U.S.C. 1011(a), as amended by Section 136 of PL 105-277). To be included, non-federal land projects must follow all elements of the ARBA II. The BLM and/or FS will ensure that projects covered under this programmatic on non-federal land undergo the same review, design, implementation and post-project processes as projects occurring on BLM and FS administered lands.

E. ARBA II Project Inclusion by Amendment

ARBA II provides flexibility to include additional restoration actions that are not identified in the present document. Existing political, social, technological, scientific, and/or capacity constraints that currently exclude certain types of restoration may change to such a degree as to allow the restoration under the ARBA II and subsequent ARBO II at a future date. For example, a new project type may have to proceed through several individual consultations before project design criteria are refined in a manner that ensures predictable effects and beneficial outcomes to ESA-listed fish. Once this predictability is achieved, the action meets a primary condition for inclusion into the ARBO II as long as the effects are similar to those already addressed in the ARBA II.

Projects can be proposed for inclusion into the ARBO II at a local or provincial scale via a Level I Team. The Level I Team shall present a consistency paper to the Restoration Review Team (RRT [see Chapter II, part G]) who will then review the paper and decide whether or not the project is consistent with the effects and beneficial outcomes described under the ARBA II. Further, the RRT can propose new actions, accompanied by a consistency document, for inclusion into the ARBO II. The consistency document shall include the following:

- Project type, description
- Ecological process and disruption being addressed
- Benefits to ESA-listed species
- How the project is consistent with ARBA II effects
- List conservation measures and project design criteria to be used that are not included in the ARBA II.

New projects that are found to be consistent with the ARBA II will be added to the ARBO II via amendment, thereby expanding an existing activity category or creating a new one.

F. ARBA II Projects funded with Timber Sale or Stewardship Contracting Receipts

Multiple sources, both federal and non-federal, may be used to fund ARBA II projects. For instance, projects may be funded by timber receipts under the Knutson-Vandenberg Act (KV). The KV projects must be non-essential to a timber sale. In doing so, a timber sale and associated aquatic restoration actions can be included in the same NEPA document but covered under different consultations, the timber sale by one and the aquatic restoration actions by this ARBA II. The ARBA II also includes projects that maybe funded through Stewardship Contracts. A joint notice detailing Stewardship actions was previously published by the BLM and FS on June 27, 2003 (68 FR 38285) to give notice and provide an opportunity for public comment on the interim guidelines for stewardship contracting .

G. Species That May Be Affected by Programmatic Action

This ARBA II covers the 20 restoration categories that occur within the range of listed species under the ESA of 1973 as amended and current critical habitat. Further, this ARBAII covers issues related to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) establishing essential fish habitat across Oregon and Washington. It also covers aquatic restoration projects that include associated terrestrial species effects that need ESA coverage. Consequently, this ARBA II covers aquatic restoration projects that may incidentally affect ESA-listed terrestrial wildlife, insect, and plant species, proposed species and designated and proposed critical habitat.

1. Fish Species

a. This assessment evaluates and describes potential effects on the following ESA-listed fish species and their respective designated and proposed critical habitat as regulated by NMFS:

i. Puget Sound Recovery Domain
   - Puget Sound Chinook salmon
   - Hood Canal Summer-Run Chum salmon
   - Lake Ozette sockeye salmon
   - Puget Sound steelhead
   - Southern DPS green sturgeon
   - Southern DPS eulachon

ii. Willamette/Lower Columbia
   - Lower Columbia River Chinook salmon
   - Upper Willamette River Chinook salmon
   - Lower Columbia coho salmon
   - Columbia River chum salmon
   - Lower Columbia River steelhead
   - Upper Willamette River steelhead
   - Southern DPS green sturgeon
   - Southern DPS eulachon

iii. Upper Columbia
    Upper Columbia River Spring-Run Chinook salmon
    Snake River Fall-Run Chinook salmon
    Snake River Spring/Summer-Run Chinook salmon
    Snake River sockeye salmon
    Middle Columbia steelhead
    Upper Columbia River Basin steelhead
    Snake River Basin steelhead
iv. Oregon Coast
    Oregon Coast coho salmon
    Southern DPS green sturgeon
    Southern DPS eulachon
v. Sothern Oregon/Northern California
    Southern Oregon/Northern California coho salmon
    Southern DPS green sturgeon
    Southern DPS eulachon
vi. EFH Chinook, coho, and pink salmon that are not listed under the ESA

b. Further, this assessment evaluates and describes potential effects on the following ESA-listed fish species and their respective critical habitat as regulated by the FWS:

Bull trout	Warner sucker	Foskett speckled dace
Lahontan cutthroat trout	Modoc sucker	
Lost River sucker	Borax chub	
Shortnose sucker	Oregon chub	

2. **Wildlife Species** – Next, this assessment evaluates and describes potential effects from aquatic restoration activities on the following ESA-listed bird and mammal species and their respective critical habitat as regulated by the FWS:

Marbled Murrelet,	Gray Wolf,
Northern Spotted Owl	Grizzly Bear,
Canada Lynx	Woodland Caribou

3. **Plant Species –** This assessment evaluates and describes potential effects on the following ESA-listed plant species and critical habitat as regulated by the FWS:

Howells's Spectacular Thelypody	MacFarlane's Four-O'clock
Showy Stickweed	Malheur Wire-Lettuce
Spalding's Catchfly	Ute Ladies'-Tresses (WA only)
Water Howellia	Kincaids Lupine
Rough Popcornflower	Macdonald's Rockcress,
Gentner's Fritillary	Nelson's checker-mallow
Western Lily	Willamette Valley Daisy
Bradshaw's Lomatium	Cook's Lomatium
Large-flowered Woolly Meadowfoam	Applegate's Milk-vetch
Wenatchee Mountains checker mallow	Golden Paintbrush

4. **Invertebrates –** Finally, this assessment evaluates and describes potential effects on the following ESA-listed invertebrate species and their respective critical habitat as regulated by the FWS:

   Fender's Blue Butterfly

Table 5 displays each FS, BLM and BIA administrative unit where proposed activities may occur and the associated ESA-listed fish, wildlife, plant, and invertebrate species that may be affected, as well as associated critical habitat. These species may occur on adjacent, non-Federal lands, where Wyden Amendment projects are likely to take place.

Table 5 – Affected ESA-Listed Species and their Designated and Proposed Critical Habitat on BLM, FS and BIA lands

Forest Service Units	State(s)	Affected Species
Colville NF	WA	**Fish** - Bull Trout (Columbia River) **Wildlife** – Canada Lynx, Gray Wolf, Grizzly Bear, woodland caribou **Plants –** None **Invertebrates** – None
Columbia River Gorge National Scenic Area	OR/WA	**Fish –** Bull Trout (Columbia River), Lower Columbia River (LCR) Chinook salmon, LCR coho salmon, Snake River (SR) spring/summer-run Chinook salmon, SR Fall Chinook salmon, SR sockeye, Columbia River (CR) chum salmon, LCR steelhead, Middle Columbia River (MCR) steelhead, Snake River Basin steelhead, Upper Columbia River (UCR) spring-run Chinook salmon, UCR steelhead, Green Sturgeon – southern DPS, Eulachon – southern DPS. **Wildlife** – Northern Spotted Owl **Plants –** Water Howellia **Invertebrates** – None
Crooked River National Grassland	OR	**Fish-**Bull Trout, MCR Steelhead **Wildlife-**none **Plants-**none **Invertebrates** – None
Deschutes	OR	**Fish –** Bull Trout (Columbia River), MCR steelhead **Wildlife –** Northern Spotted Owl **Plants** None **Invertebrates** – None
Fremont/Winema	OR	**Fish –** Bull Trout (Klamath), Lost River Sucker, Modoc Sucker, Shortnose Sucker, Warner Sucker, SONC coho salmon? **Wildlife –** Northern Spotted Owl **Plants –** None **Invertebrates** – None
Gifford Pinchot	WA	**Fish –** Bull Trout (Coastal/Puget Sound, Columbia River), LCR Chinook salmon, LCR steelhead, LCR coho salmon, MCR Steelhead **Wildlife –** Marbled Murrelet, Northern Spotted Owl, Gray Wolf **Plants –** None **Invertebrates** – None
Malheur	OR	**Fish –** Bull Trout (Columbia River), MCR Steelhead **Wildlife –** Canada Lynx, Gray Wolf **Plants –** None **Invertebrates** – None

Table 5 (continued) – Affected ESA-Listed Species and their Designated and Proposed Critical Habitat on FS, BLM and Coquille lands.

Forest Service Units	State(s)	Affected Species
Mt. Hood	OR	**Fish –** Bull Trout (Columbia River), Upper Willamette River (UWR) Chinook salmon, UWR steelhead, LCR Chinook salmon, LCR Steelhead, MCR Steelhead, LCR coho, southern DPS eulachon **Wildlife –** Northern Spotted Owl **Plants –** None **Invertebrates** – None
Ochoco	OR	**Fish -** Bull Trout (Columbia River), MCR Steelhead **Wildlife –** None **Plants –** None **Invertebrates** – None
Okanogan/Wenatchee	WA	**Fish –** Bull Trout (Columbia River), Upper Columbia River Spring-Run Chinook Salmon, Middle Columbia River Steelhead, Upper Columbia River Steelhead **Wildlife –**Northern Bald Eagle, Northern Spotted Owl, Marbled Murrelet, Canada Lynx, Gray Wolf, Grizzly Bear **Plants –** Showy Stickseed, Ute Ladies'-tresses, Water Howellia, Wenatchee Mountains Checker-Mallow **Invertebrates** – None
Olympic	WA	**Fish -** Bull Trout (Coastal/Puget Sound), Puget Sound Chinook Salmon, Hood Canal summer-run chum salmon, , Puget Sound steelhead **Wildlife –**Marbled Murrelet, Northern Spotted Owl **Plants –** None **Invertebrates** – None
Rogue River/Siskiyou	OR/CA	**Fish –** Southern Oregon/Northern California coho salmon, Oregon Coast (OC) coho salmon **Wildlife –**Northern Spotted Owl, Marbled Murrelet **Plants –** MacDonald's Rockcress, Gentner's Fritillary **Invertebrates** – None
Siuslaw	OR	**Fish –** OC coho salmon, UWR spring Chinook salmon, UWR steelhead **Wildlife –**Northern Spotted Owl, Marbled Murrelet **Plants –** Western Lily, Nelson's checker mallow **Invertebrates** – None
Umatilla	OR/WA	**Fish –** Bull Trout (Columbia River), SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, MCR steelhead, SRB steelhead **Wildlife –**Gray Wolf **Plants –** Spalding's Catchfly **Invertebrates** – None
Umpqua	OR	**Fish –** OC coho salmon **Wildlife –** Northern Spotted Owl, **Plants** – Kincaid's Lupine, Rough Popcorn Flower **Invertebrates** – None

Table 5 (continued) – Affected ESA-Listed Species and their Designated and Proposed Critical Habitat on FS, BLM and Coquille lands.

Forest Service Units	State(s)	Affected Species
Willamette	OR	**Fish –** Bull Trout (Columbia River), Oregon chub, UWR spring Chinook salmon, UWR steelhead **Wildlife –**Northern Spotted Owl. **Plants –**None **Invertebrates** – None
Bureau of Land Management	**State(s)**	**Affected Species**
Burns	OR	**Fish –** Bull Trout (Columbia River), Lahontan Cutthroat Trout**,** Borax Lake Chub **Wildlife** –Canada Lynx, Sage Grouse **Plants –** Malheur Wire Lettuce **Invertebrates** – None
Coos Bay	OR	**Fish –** SONC coho salmon, OC coho salmon **Wildlife –**Marbled Murrelet, Northern Spotted Owl**,** Western Snowy Plover, Streaked Horned Lark **Plants –** Western Lily **Invertebrates** – None
Eugene	OR	**Fish** – Bull Trout, UWR spring-run Chinook salmon, OC coho salmon, UWR steelhead, Oregon Chub **Wildlife** –Northern Spotted Owl, Marbled Murrelet, , **Plants** – Kincaid's Lupine, Willamette Daisy, Bradshaw's Lomatium, Golden Paintbrush, Water Howellia **Invertebrates** – Fenders Blue Butterfly
Lakeview	OR	**Fish** – Bull Trout (Klamath),Warner Sucker, Foskett Speckled Dace, Lost River Sucker, shortnose Sucker **Wildlife** –Northern Spotted Owl **Plants** – Applegate's Milk-Vetch, Gentner's Fritillary **Invertebrates** – None
Medford	OR	**Fish** –SONCC coho salmon, OC coho salmon, **Wildlife** –Marbled Murrelet, Northern Spotted Owl **Plants** – Gentner's Fritillary, Cook's Lomatium **Invertebrates** - Vernal Pool Fairy Shrimp
Prineville	OR	**Fish** – Bull Trout, MCR steelhead **Wildlife** –Canada Lynx, Sage Grouse **Plants** – None **Invertebrates** – None
Roseburg	OR	**Fish** –OC coho salmon **Wildlife** –Northern Spotted Owl, Marbled Murrelet **Plants** – Rough Popcorn flower, Kincaid's Lupine **Invertebrates** – None

Table 5 (continued) – Affected ESA-Listed Species and their Designated and Proposed Critical Habitat on FS, BLM and Coquille lands.		
Bureau of Land Management	**State(s)**	**Affected Species**
Spokane	WA	**Fish** – Bull Trout (Columbia River), UCR spring-run Chinook salmon, UCR steelhead, , MCR steelhead **Wildlife** –Gray Wolf, Woodland Caribou, Washington Ground Squirrel, Canada Lynx, Grizzly Bear, Greater Sage Grouse, Marbled Murrelet **Plants** – Showy Stickseed, Golden Paintbrush, Umtanum Desert Buckwheat, Whitebluff's Bladderpod, Kincaid's Lupine, Wenatchee Mountain checker mallow, Nelson's Checkermallow, Spalding's Catchfly, Ute's Ladies-Tresses, Water Howellia **Invertebrates** – None
Vale	OR/NE	**Fish** – Bull Trout (Columbia River), SR fall Chinook salmon, SR spring/summer-run Chinook salmon, SRB steelhead, SR sockeye salmon, , Lahontan Cutthroat Trout **Wildlife** –Canada Lynx, Gray Wolf, Sage Grouse. **Plants** – Howell's Spectacular Thelypody, MacFarlane's Four O'Clock, Spalding's Catchfly **Invertebrates** – None
BIA, Coquille Indian Tribe	State	**Affected Species**
	OR	**Fish** – OC coho salmon **Wildlife** –Northern Spotted Owl, Marbled Murrelet **Plants** – none **Invertebrates** – None

II. Description of the Programmatic Aquatic Restoration Activity Categories and Supporting Measures

The BLM, FS and BIA propose to implement 20 aquatic restoration activities under this ARBA II. To provide context for these categories, this section includes the following: Project Administration, General Aquatic Conservation Measures (ACM), General Wildlife Measures, and Project Descriptions and Design Criteria (PDC). The ACM and PDC were developed to minimize adverse effects to the aquatic environment and ESA-listed fish and their designated Critical Habitat as well as MSA habitats.

A. Program Administration

Program administration of ARBA II will be guided by the following reporting, meeting, and coordination requirements.

1. **Integration of Project Design Criteria (PDC) and Conservation Measures and Terms and Conditions into Project Design and Contract Language** – Appropriate aquatic and terrestrial CMs along with PDCs listed in this ARBA II along with any terms and conditions included in the subsequent ARBO II shall be incorporated into contract language or force-account implementation plans.
2. **Project Notification** –Level 1 teams will review and discuss aquatic restoration projects planned for implementation during an upcoming work season through their team-specific processes. Because the ARBA II activities have already proceeded through formal consultation, additional approvals are not required by the BLM, FS or BIA from the NMFS or FWS Level 1 Team members. A Project Notification Form shall be provided to the NMFS/FWS Level I Aquatics Team and FWS Level I Terrestrial Team (in areas of NSO and MM) members 30 days prior to implementation and will include the following information:
   a. Action identifier – The same unique identification number is necessary for each project's Action Notification and Project Completion report.
   b. Project Name – Use the same project name from notification to completion (i.e., Jones Creek, Tillamook Co. OR, culvert replacement).
   c. Location – 6th field HUC, stream name, and latitude and longitude (decimal degrees)
   d. Agency Contact – Agency and project lead name
   e. Timing – Project start and end dates
   f. Activity Type – As listed in section I. B. of this ARBA II
   g. Project Description – Brief narrative of the project and objectives
   h. Extent – Number of stream miles or acres to be treated
   i. Species Affected – Listed Fish and or Wildlife species, Critical Habitat, and or EFH affected by project
   j. Date of Submittal
   k. For any action requiring a site assessment for contaminants, include a copy of the report explaining the likelihood that contaminants are present at the site.
   l. For any action requiring a NMFS Hydro Fish Passage Review and Approve and a Restoration Review Team review, attach a copy of the approval correspondence. Refer to sections "F" and "G" of this chapter.

m. Verification – Check box that verifies that all appropriate General Aquatic Conservation Measures, Wildlife Conservation Measures, Project Design Criteria for Aquatic Restoration Activity Categories, and Project Design Criteria for Terrestrial Species and Habitats have been thoroughly reviewed and will be incorporated into project design, implementation, and monitoring.

3. **Project Completion Report** – Level 1 teams will discuss and review aquatic restoration projects completed during a previous season. The BLM, FS, and BIA field offices will submit a project completion report to their FWS and NMFS Level I Team counterparts on all projects implemented during a given year. The project contact will complete and send reports to the FWS Level I Terrestrial Team in areas of NSO and MAMU. Reports are due 60 days after project completion. Reports will include the following information:
   a. Action identifier (same number as in notification)
   b. Action name (same name as in notification)
   c. Location – 6th field HUC, stream name, latitude and longitude
   d. Agency Contact – Agency and project lead name
   e. Timing – Actual project start and end dates
   f. Activity Type – As listed in section I. B. of this ARBA II
   g. Project Description – Brief narrative of the completed project and objectives
   h. Extent – Number of stream miles or acres treated
   i. Species effected – Fish and or Wildlife species affected by the project, Critical Habitat and or EFH
   j. Number of Northern Spotted Owl, or Marbled Murrelet nests disrupted and disturbed during critical nesting period
   k. Fish Pursuit and Capture – If fish are pursued and/or captured during salvage operations, the project biologist will describe removal methods, stream conditions, and the number of fish handled, injured, or killed. More detailed information will be required for excessive mortality. This report will likely be limited to fish passage, dam removal, and channel restoration/relocation projects.
   l. State-specific 401 Certification monitoring results. If protocol conditions were not met, describe effects and any remedial actions.
   m. Post Project Assessment – Effects not considered and remedial actions taken, including any dates work ceased due to high flows
   n. Date of Submittal

4. **Annual Program Report –** The BLM Oregon State Office, FS Region 6 Office, and BIA will provide an annual program report to NMFS and FWS by February 15 of each year that describes BLM, FS and BIA projects implemented under ARBO II. The report will include the following information:
   a. An assessment of overall program activity
   b. A map showing the location and type of each action carried out under ARBO II
   c. A list of any actions which BLM, FS and BIA funded or carried out using the ARBO II and any actions for which BLM, FS and BIA was designated as the lead agency for ESA purposes
   d. Data or analyses that the BLM, FS and BIA deem necessary or helpful to assess habitat trends as a result of actions carried out under the ARBO II

5. **Annual Coordination Meeting –** The BLM Oregon State Office, FS Region 6 Office, and BIA will meet with NMFS and FWS by April 30 each year to discuss the annual monitoring report and any actions that will improve conservation under the ARBO II or make the program more efficient or accountable.

B. General Aquatic Conservation Measures

General Aquatic Conservation Measures (ACM) are intended to minimize effects to the aquatic environment, and the following apply, when relevant, to all 20 aquatic restoration categories.

1. **Minor Variance Process** – Because of the wide range of proposed activities and the natural variability within and between stream systems, some projects may require minor variations from criteria specified herein. The Services will consider granting variances, especially when there is a clear conservation benefit or there are no additional adverse effects (especially take) beyond that covered by the ARBO II. Minor variance requests must:
   a. cite ARBO II identifying number
   b. cite the relevant criterion by page number
   c. define the requested variance
   d. explain why the variance is necessary
   e. provide a rationale why the variance will either provide a conservation benefit or, at a minimum, not cause additional adverse effects
   f. include as attachments any necessary approvals by state agencies
   g. Minor variances can be authorized by the Services at the NMFS Branch Chief or FWS Field Office Supervisor level.
2. **Technical Skill and Planning Requirements**
   a. Ensure that an experienced fisheries biologist or hydrologist is involved in the design of all projects covered by this ARBA II. The experience should be commensurate with technical requirements of a project.
   b. Planning and design includes field evaluations and site-specific surveys, which may include reference reach evaluations that describe the appropriate geomorphic context in which to implement the project. Planning and design involves appropriate expertise from staff or experienced technicians (e.g., fisheries biologist, hydrologist, geomorphologist, wildlife biologist, botanist, engineer, silviculturist, fire/fuels specialists.)
   c. The project fisheries biologist/hydrologist will ensure that project design criteria are incorporated into implementation contracts. If a biologist or hydrologist is not the Contracting Officers Representative (COR), then the biologist or hydrologist must regularly coordinate with the project COR to ensure the project design criteria and conservation measures are being followed.
3. **Climate Change** – Consider climate change information, such as predictive hydrographs for a given watershed or region, when designing ARBA II projects.
4. **Lamprey –** To the extent possible, incorporate lamprey BMPs found in Best Management Practices to Minimize Adverse Effects to Pacific Lamprey, Entosphenus tridentatus (USFWS 2010).

5. **In-water Work Period –** Follow the appropriate state (ODFW 2008 or WDFW 2010 or most recent) guidelines for timing of in-water work:

   ODFW
   (http://www.dfw.state.or.us/lands/inwater/Oregon_Guidelines_for_Timing_of_%20InWater_work2008.pdf)
   WDFW
   (http://wdfw.wa.gov/licensing/hpa/freshwater_incubation_avoidance_times_28may2010.pdf)

   If work occurs in occupied Oregon chub habitat, in-water work will not occur between June 1 and August 15. In those few instances when projects will be implemented in California, Idaho, or Nevada, follow appropriate state guidelines. Exceptions to in-water work windows must be requested and granted through Level I NMFS and/or FWS representatives as well as essential state agencies. For National Forests in the state of Washington, the FS will work with WDFW to determine in-water work periods, using the process contained in the 2011 MOU between the WDFW and USDA Forest Service, Pacific Northwest Region regarding hydrologic permits.
6. **Fish Passage –** Fish passage will be provided for any adult or juvenile fish likely to be present in the action area during construction, unless passage did not exist before construction, stream isolation and dewatering is required during project implementation, or where the stream reach is naturally impassible at the time of construction. After construction, adult and juvenile passage that meets NMFS's fish passage criteria (NMFS 2011) will be provided for the life of the action.
7. **Site Assessment for Contaminants** – In developed or previously developed sites, such as areas with past dredge mines, or sites with known or suspected contamination, a site assessment for contaminants will be conducted on projects that involve excavation of > 20 cubic yards of material. The action agencies will complete a site assessment to identify the type, quantity, and extent of any potential contamination. The level of detail and resources committed to such an assessment will be commensurate with the level and type of past or current development at the site. The assessment may include the following:
   a. Review of readily available records, such as former site use, building plans, records of any prior contamination events
   b. Site visit to observe the areas used for various industrial processes and the condition of the property
   c. Interviews with knowledgeable people, such as site owners, operators, occupants, neighbors, local government officials, etc.
   d. Report that includes an assessment of the likelihood that contaminants are present at the site.
8. **Pollution and Erosion Control Measures (PCEM) –** When heavy machinery will be used to complete a project, implement the following PCEMs:
   a. Project Contact: Identify a project contact (name, phone number, an address) who will be responsible for implementing PCEMs.

b. List and describe any hazardous material that would be used at the project site, including procedures for inventory, storage, handling, and monitoring; notification procedures; specific clean-up and disposal instructions for different products available on the site; proposed methods for disposal of spilled material; and employee training for spill containment.
c. Temporarily store any waste liquids generated at the staging areas under cover on an impervious surface, such as tarpaulins, until such time they can be properly transported to and treated at an approved facility for treatment of hazardous materials.
d. Procedures based on Best Management Practices to confine, remove, and dispose of construction waste, including every type of debris, discharge water, concrete, cement, grout, washout facility, welding slag, petroleum product, or other hazardous materials generated, used, or stored on-site.
e. Procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities. Ensure that materials for emergency erosion and hazardous materials control are onsite (e.g., silt fence, straw bales, oil-absorbing floating boom whenever surface water is present).
f. Best management practices to confine vegetation and soil disturbance to the minimum area, and minimum length of time, as necessary to complete the action, and otherwise prevent or minimize erosion associated with the action area.
g. No uncured concrete or form materials will be allowed to enter the active stream channel.
h. Steps to cease work under high flows, except for efforts to avoid or minimize resource damage.

9. Site Preparation

a. **Flagging Sensitive Areas** – Prior to construction, flag critical riparian vegetation areas, wetlands, and other sensitive sites to minimize ground disturbance.
b. **Staging Area**– Establish staging areas for storage of vehicles, equipment, and fuels to minimize erosion into or contamination of streams and floodplains.
   i. No Topographical Restrictions – place staging area 150 feet or more from any natural water body or wetland in areas where topography does not restrict such a distance.
   ii. Topographical Restrictions –place staging area away from any natural water body or wetland to the greatest extent possible in areas with high topographical restriction, such as constricted valley types. .
c. **Temporary Erosion Controls** – Place sediment barriers prior to construction around sites where significant levels of erosion may enter the stream directly or through road ditches. Temporary erosion controls will be in place before any significant alteration of the action site and will be removed once the site has been stabilized following construction activities.
d. **Stockpile Materials** – Minimize clearing and grubbing activities when preparing staging, project, and or stockpile areas. Any large wood, topsoil, and native channel material displaced by construction will be stockpiled for use during site restoration. Materials used for implementation of aquatic

restoration categories (e.g., large wood, boulders, fencing material etc.) may be staged within the 100-year floodplain.

e. **Hazard Trees** - Where appropriate, include hazard tree removal (amount and type) in project design. Fell hazard trees within riparian areas when they pose a safety risk. If possible, fell trees towards a stream. Keep felled trees on site when needed to meet coarse woody debris objectives.

10. Heavy Equipment Use

a. **Choice of Equipment –** Heavy equipment will be commensurate with the project and operated in a manner that minimizes adverse effects to the environment (e.g., minimally-sized, low pressure tires, minimal hard turn paths for tracked vehicles, temporary mats or plates within wet areas or sensitive soils).

b. **Fueling and Cleaning and Inspection for Petroleum Products and Invasive Weeds**

   i. All equipment used for instream work will be cleaned for petroleum accumulations, dirt, plant material (to prevent the spread of noxious weeds), and leaks repaired prior to entering the project area. Such equipment includes large machinery, stationary power equipment (e.g., generators, canes, etc.), and gas-powered equipment with tanks larger than five gallons.

   ii. Store and fuel equipment in staging areas after daily use.

   iii. Inspect daily for fluid leaks before leaving the vehicle staging area for operation.

   iv. Thoroughly clean equipment before operation below ordinary high water or within 50 feet of any natural water body or areas that drain directly to streams or wetlands and as often as necessary during operation to remain grease free.

c. **Temporary Access Roads –** Existing roadways or travel paths will be used whenever possible. Minimize the number of temporary access roads to lessen soil disturbance and compaction and impacts to vegetation. Temporary access roads will not be built on slopes where grade, soil, or other features suggest a likelihood of excessive erosion or failure. When necessary, temporary access roads will be obliterated and/or revegetated. Temporary roads in wet or flooded areas will be restored by the end of the applicable in-water work period. Construction of new permanent roads is not permitted.

d. **Stream Crossings** – Minimize number and length of stream crossings. Such crossings will be at right angles and avoid potential spawning areas to the greatest extent possible. Stream crossings shall not increase the risk of channel re-routing at low and high water conditions. After project completion, temporary stream crossings will be abandoned and the stream channel and banks restored.

e. **Work from Top of Bank –** To the extent feasible, heavy equipment will work from the top of the bank, unless work from another location (instream) would result in less habitat disturbance, less floodplain disturbance, and/or better meet ARBA II design criteria. In another way, operate heavy equipment in streams only when project specialists believe that such actions are the only reasonable alternative for implementation, or would result in less sediment in the stream channel or damage (short- or long-term) to the overall aquatic and riparian ecosystem relative to other alternatives.

f. **Timely Completion** – Minimize time in which heavy equipment is in stream channels, riparian areas, and wetlands. Complete earthwork (including drilling, excavation, dredging, filling and compacting) as quickly as possible. During excavation, stockpile native streambed materials above the bankfull elevation, where it cannot reenter the stream, for later use.

11. Site Restoration

a. **Initiate Rehabilitation** – Upon project completion, rehabilitate all disturbed areas in a manner that results in similar or better than pre-work conditions through removal of project related waste, spreading of stockpiled materials (soil, large wood, trees, etc.) seeding, and/or planting with local native seed mixes or plants.

b. **Short-term Stabilization** – Measures may include the use of non-native sterile seed mix (when native seeds are not available), weed-free certified straw, jute matting, and other similar techniques. Short-term stabilization measures will be maintained until permanent erosion control measures are effective. Stabilization measures will be instigated within three days of construction completion.

c. **Revegetation** – Replant each area requiring revegetation prior to or at the beginning of the first growing season following construction. Achieve re-establishment of vegetation in disturbed areas to at least 70% of pre-project levels within three years. Use an appropriate mix of species that will achieve establishment and erosion control objectives, preferably forb, grass, shrub, or tree species native to the project area or region and appropriate to the site. Barriers will be installed as necessary to prevent access to revegetated sites by livestock or unauthorized persons.

d. **Planting Manuals** – All riparian plantings shall follow Forest Service direction described in the Regional letter to Units, Use of Native and Nonnative Plants on National Forests and Grasslands May 2006 (Final Draft), and or BLM Instruction Memorandum No. OR-2001-014, Policy on the Use of Native Species Plant Material.

e. **Decompact Soils** – When necessary, loosen compacted areas, such as access roads and paths, stream crossings, staging, and stockpile areas.

12. Monitoring – Monitoring will be conducted by BLM, FS, or BIA staff during and after a project to track effects and compliance with ARBA II.

a. **Implementation**

i. Visually monitor during project implementation to ensure effects are not greater (amount, extent) than anticipated and to contact Level 1 representatives if problems arise.

ii. Fix any problems that arise during project implementation.

iii. Regular biologist/hydrologist coordination with COR if biologist/hydrologist is not always on site to ensure contractor is following all stipulations.

b. **401 Certification** – To minimize short-term degradation to water quality during project implementation, follow current 401 Certification provisions of the Federal Clean Water Act for maintenance or water quality standards described by the following: Oregon Department of Environmental Quality (Oregon BLM, FS and BIA); Washington Department of Ecology (Washington BLM); and the MOU between the Washington Department of Fish and Wildlife and FS regarding Hydraulic Projects Conducted by FS, Pacific Northwest Region (FS); California, Idaho, or Nevada 401 Certification protocols (BLM and FS).

c. **Post Project** – A post-project review shall be conducted after winter and spring high flows.

   i. For each project, conduct a walk through/visual observation to determine if there are post-project affects that were not considered during consultation? For fish passage and revegetation projects, monitor in the following manner:

      (a) **Fish Passage Projects** – Note any problems with channel scour or bedload deposition, substrate, discontinuous flow, vegetation establishment, or invasive plant infestation.

      (b) **Revegetation** – For all plant treatment projects, including site restoration, monitor for and remove invasive plants until native plants become established.

   ii. In cases where remedial action is required, such actions are permitted without additional consultation if they use relevant ARBA II PDCs and ACMs and the effects of ARBA II programmatic actions are not exceeded.

C. Work Area Isolation & Fish Capture and Release

Isolate the construction area and remove fish from a project site for projects that include concentrated and major excavation at a single location within the stream channel. This condition will typically apply to the following aquatic restoration categories: Fish Passage Restoration; Dam, Tidegate, and Legacy Structure Removal; Channel Reconstruction/Relocation.

1. **Isolate Capture Area –** Install block nets at up and downstream locations outside of the construction zone and leave in a secured position to exclude fish from entering the project area. Leave nets secured to the stream channel bed and banks until construction activities within the stream channel are complete. If block nets or traps remain in place more than one day, monitor the nets and or traps at least on a daily basis to ensure they are secured to the banks and free of organic accumulation and to minimize fish predation in the trap.
2. **Capture and release –** Fish trapped within the isolated work area will be captured and released as prudent to minimize the risk of injury, then released at a safe release site, preferably upstream of the isolated reach in a pool or other area that provides cover and flow refuge. Collect fish by seine or dip nets as the area is slowly dewatered, and minnow traps will be in place overnight. Fish must be handled with extreme care and kept in water the maximum extent possible during transfer procedures. A healthy environment for the stressed fish shall be provided—large buckets (five-gallon minimum to prevent overcrowding) and

minimal handling of fish. Place large fish in buckets separate from smaller prey-sized fish. Monitor water temperature in buckets and well-being of captured fish. If buckets are not being immediately transported, use aerators to maintain water quality. As rapidly as possible (especially for temperature-sensitive bull trout), but after fish have recovered, release fish. In cases where the stream is intermittent upstream, release fish in downstream areas and away from the influence of the construction. Capture and release will be supervised by a fishery biologist experienced with work area isolation and safe handling of all fish.

3. **Electrofishing –** Use electrofishing only where other means of fish capture may not be feasible or effective. If electrofishing will be used to capture fish for salvage, NMFS' electrofishing guidelines will be followed (NMFS 2000 - http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf). Those guidelines are available from the NMFS Northwest Region, Protected Resources Division in Portland, Oregon.
    a. Reasonable effort should be made to avoid handling fish in warm water temperatures, such as conducting fish evacuation first thing in the morning, when the water temperature would likely be coolest. No electrofishing should occur when water temperatures are above 18ºC or are expected to rise above this temperature prior to concluding the fish capture.
    b. If fish are observed spawning during the in-water work period, electrofishing shall not be conducted in the vicinity of spawning adult fish or active redds.
    c. Only Direct Current (DC) or Pulsed Direct Current (PDC) shall be used.
    d. Conductivity <100, use voltage ranges from 900 to 1100. Conductivity from 100 to 300, use voltage ranges from 500 to 800. Conductivity greater than 300, use voltage to 400.
    e. Begin electrofishing with minimum pulse width and recommended voltage and then gradually increase to the point where fish are immobilized and captured. Turn off current once fish are immobilized.
    f. Do not allow fish to come into contact with anode. Do not electrofish an area for an extended period of time. Remove fish immediately from water and handle as described below. Dark bands on the fish indicate injury, suggesting a reduction in voltage and pulse width and longer recovery time.
    g. If mortality is occurring during salvage, immediately discontinue salvage operations (unless this would result in additional fish mortality), reevaluate the current procedures, and adjust or postpone procedures to reduce mortality.

4. **Dewater Construction Site** –When dewatering is necessary to protect species and/or critical habitat, divert flow around the construction site with a coffer dam (built with non-erosive materials) and an associated pump, a by-pass culvert, or a water-proof lined diversion ditch. Diversion sandbags can be filled with material mined from the floodplain as long as such material is replaced at end of project. Small amounts of instream material can be moved to help seal and secure diversion structures. Pumps must have fish screens and be operated in accordance with NMFS fish screen criteria described in part 5 of this section. Dissipate flow energy at the bypass outflow to prevent damage to riparian vegetation or stream channel. If diversion allows for downstream fish passage, place diversion outlet in a location to promote safe reentry of fish into the stream channel, preferably into

pool habitat with cover. When necessary, pump seepage water from the de-watered work area to a temporary storage and treatment site or into upland areas and allow water to filter through vegetation prior to reentering the stream channel.

5. **Fish screens for Dewatering**
   a. **NMFS Hydro Fish Passage Review and Approve –** When using Fish screens for surface water that is diverted by gravity or by pumping at a rate that exceeds 3 cfs, the BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf Refer to section "F" of this chapter.
   b. For the dewatering of a work site to remove or install culverts, bridge abutments, etc. a fish screen must be used on the pump intake to avoid juvenile fish entrainment that meets criteria specified by NMFS (2011, or most recent version).
   c. All other diversions will have a fish screen that meets the following specifications: (a) An automated cleaning device with a minimum effective surface area of 2.5 square feet per cfs, and a nominal maximum approach velocity of 0.4 feet per second (fps), <u>or</u> no automated cleaning device, a minimum effective surface area of 1 square foot per cfs, and a nominal maximum approach rate of 0.2 fps; <u>and</u> (b) a round or square screen mesh that is no larger than 2.38 mm (0.094") in the narrow dimension, <u>or</u> any other shape that is no larger than 1.75 mm (0.069") in the narrow dimension.
   d. Each fish screen will be installed, operated, and maintained according to NMFS' fish screen criteria (NMFS 2011, or most recent version). NMFS fish screen criteria applies to federally listed salmonid species under their jurisdiction as well as bull trout, Oregon chub, shortnose sucker, Lahontan cutthroat trout, Lost River sucker, Modoc sucker, and Warner sucker under FWS jurisdiction.
6. **Stream Re-watering –** Upon project completion, slowly re-water the construction site to prevent loss of surface water downstream as the construction site streambed absorbs water and to prevent a sudden increase in stream turbidity. Monitor downstream during re-watering to prevent stranding of aquatic organisms below the construction site.
7. **Salvage Notice –** NOTICE: If a sick, injured, or dead specimen of a threatened or endangered species is found in the project area, the finder must notify NMFS through the contact person identified in the transmittal letter for this opinion, or through the NMFS Office of Law Enforcement at 1-800-853-1964, and follow any instructions. If the proposed action may worsen the fish's condition before NMFS can be contacted, the finder should attempt to move the fish to a suitable location near the capture site while keeping the fish in the water and reducing its stress as much as possible. Do not disturb the fish after it has been moved. If the fish is dead, or dies while being captured or moved, report the following information: (a) NMFS consultation number; (b) the date, time, and location of discovery; (c) a brief description of circumstances and any information that may

show the cause of death; and (d) photographs of the fish and where it was found. The NMFS also suggests that the finder coordinate with local biologists to recover any tags or other relevant research information. If the specimen is not needed by local biologists for tag recovery or by NMFS for analysis, the specimen should be returned to the water in which it was found, or otherwise discarded.

D. General Wildlife Conservation Measures

1. An action agency wildlife biologist shall participate in the planning and design of all activities affecting listed terrestrial species.
2. To ensure ESA consistency for terrestrial species, final design and contract packages must be reviewed by an action agency wildlife biologist prior to their approval/implementation. A primary concern is that work be conducted during the appropriate wildlife work windows.
3. A known nest tree may be removed only when it is an immediate danger, when the tree is unoccupied by nesting birds or their young, and will be consulted on after the fact in an Emergency consultation. The proposed project will only have an insignificant or discountable effect to spotted owls or murrelets due to habitat modifications.
4. To minimize risk to murrelets from attracting predators to activity areas, remove or contain all garbage (especially food products) on a daily basis from the vicinity of any activity.
5. Activities associated with projects within the disruption distance of known occupied or unsurveyed suitable murrelet habitat, or unsurveyed potential nesting structure, and implemented in the marbled murrelet breeding season would not begin until 2 hours after sunrise and would end 2 hours before sunset.
6. Tree removal must not contain any nesting structure for murrelets, nor contain a spotted owl nest. Minimum nest tree dbh may range from 11" to 18" depending on site specific conditions and may vary from unit to unit.
7. An action agency wildlife biologist must be involved in the project, including decisions on whether individual trees are suitable for nesting and in developing local habitat maps for the area which will be used for applying timing restrictions based on Tables 10, 11 and 12.

E. Project Design Criteria for Aquatic Restoration Activity Categories

The 20 aquatic restoration activity categories will be designed and implemented to help restore watershed processes as highlighted in Tables 3 and 4. These projects will improve channel dimensions and stability, sediment transport and deposition, and riparian, wetland, floodplain and hydrologic functions, as well as water quality. As such, these improvements will help address limiting factors—related to spawning, rearing, migration, and more—for ESA-listed and other native fish species. Aquatic habitat restoration and enhancement projects are conducted within stream channels, adjacent riparian/floodplain areas, wetlands, and uplands. Work may be accomplished using manual labor, hand tools (chainsaws, tree planting tools, augers, shovels, and more), all-terrain vehicles, flat-bed trucks, and heavy equipment (backhoes, excavators, bulldozers, front-end loaders, dump trucks, winch machinery, cable yarding, etc.). Helicopters will be used for many large wood and salmon carcass placement projects.

The following Project Design Criteria (PDC) were developed to guide the design of aquatic restoration projects to be implemented under ARBA II and does not include wildlife, plant, or invertebrate PDC that maybe required. Such PDC are listed in Chapter II, part H of this ARBA II.

1. **Fish Passage Restoration** includes the following: total removal of culverts or bridges, or replacing culverts or bridges with properly sized culverts and bridges, replacing a damaged culvert or bridge, and resetting an existing culvert that was improperly installed or damaged; stabilizing and providing passage over headcuts; removing, constructing (including relocations), repairing, or maintaining fish ladders; and replacing, relocating, or constructing fish screens and irrigation diversions. Such projects will take place where fish passage has been partially or completely eliminated through road construction, stream degradation, creation of small dams and weirs, and irrigation diversions. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.
    a. **Stream Simulation Culvert and Bridge Projects –** All road-stream crossing structures shall simulate stream channel conditions per *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USFS 2008), located at: http://stream.fs.fed.us/fishxing/aop_pdfs.html .
        i. **Culvert Criteria** – Within the considerations of stream simulation, the structure shall, at a minimum, accommodate a bankfull wide channel plus constructed banks to provide for passage of all life stages of native fish species (for more information, reference Chapter 6, page 35 of the USFS Stream Simulation Guide). The following crossing-width guidance applies to specific ranges of entrenchment ratios as defined by Rosgen (1996):
            (a) Non-entrenched Streams: If a stream is not fully entrenched (entrenchment ratio of greater than 1.4), the minimum culvert width shall be at least 1.3 times the bankfull channel width. This is consistent with the *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (section 7.4.2 "Stream Simulation Design") (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf However, if the appropriate structure width is determined to be less than 1.3 times the bankfull channel width, processes for variances are listed in "iv" and "v" below.
            (b) Entrenched Streams: If a stream is entrenched (entrenchment ratio of less than 1.4), the culvert width must be greater than bankfull channel width, allow sufficient vertical clearance to allow ease of construction and maintenance activities, and provide adequate room for the construction of natural channel banks. Consideration should be given

to accommodate the floodprone width. Floodprone is the width measured at twice the maximum bankfull depth (Rosgen, 1996).

ii. **Bridge Design**

(a) Bridges with vertical abutments—including concrete box culverts, which are constructed as bridges—shall have their stream channels, including width, designed according to culvert guidelines.

(b) Structure material must be concrete or metal. Concrete must be sufficiently cured or dried before coming into contact with stream flow. The use of treated wood for bridge construction or replacement is not allowed under this ARBA II.

(c) Riprap must not be placed within the bankfull width of the stream. Riprap may only be placed below bankfull height when necessary for protection of abutments and pilings. However, the amount and placement of riprap should not constrict the bankfull flow.

iii. **Crossing Design**

(a) Crossings shall be designed using an interdisciplinary design team consisting of an experienced Engineer, Fisheries Biologist, and Hydrologist/Geomorphologist.

(b) Crossing structures with widths that exceed 20 feet or with costs that exceed $100,000 shall be reviewed by the USDA Forest Service AOP Design Assistance Team or a BLM equivalent.

(c) At least one member of the design team shall be trained in a week-long Aquatic Organism Passage course based on the USDA Forest Service's guide, *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USFS 2008*)* http://stream.fs.fed.us/fishxing/aop_pdfs.html.

(d) Bankfull width shall be based on the upper end of the distribution of bankfull width measurements as measured in the reference reach to account for channel variability and dynamics.

iv. **NMFS Hydro Fish Passage Review and Approve -** If the structure width is determined to be less than the established width criteria as defined above, a variance may be requested from the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in NMFS (2011). Refer to section "F" of this chapter.

v. **Opportunity for Individual Level 1 Consultation** – Action Agencies have the opportunity to consult with NOAA Fisheries and USFWS on a project-specific basis if they prefer to operate outside the conditions in ARBA II. The standards provided in this document are conservative for the purpose of this programmatic and may or may not be applicable to projects that undergo individual Level I Consultation. The standards in this ARBA II are not new defaults to be used universally outside the programmatic arena.

b. **Headcut and Grade Stabilization –** Headcuts often occur in meadow areas, typically on Rosgen "C" and "E" channel types. Headcuts develop and migrate during bankfull and larger floods, when the sinuous path of Rosgen E type streams may become unstable in erosive, alluvial sediments, causing avulsions, meander cut-offs, bank failure, and development of an entrenched Rosgen G gully channel (Rosgen 1994).

i. **Stabilize Headcuts**
   (a) Armor headcut with sufficiently sized and amounts of material to prevent continued up-stream migration of the headcut. Materials can include both rock and organic materials which are native to the area. Material shall not contain gabion baskets, sheet pile, concrete, articulated concrete block, and cable anchors.
   (b) Focus stabilization efforts in the plunge pool, the headcut, as well as a short distance of stream above the headcut.
   (c) Minimize lateral migration of channel around headcut ("flanking") by placing rocks and organic material at a lower elevation in the center of the channel cross section to direct flows to the middle of channel.
   (d) In streams with current or historic fish presence, provide fish passage over stabilized headcut through constructed riffles for pool/riffle streams or a series of log or rock weir structures for step/pool channels as described in part ii below.
   (e) Short-term headcut stabilization (including emergency stabilization projects) may occur without associated fish passage measures. However, fish passage must be incorporated into the final headcut stabilization action and be completed during the first subsequent in-water work period.
   (f) In streams without current or historic fish presence, it is recommended to construct a series of downstream log or rock weirs as described in part ii below to expedite channel aggradation.

ii. **Grade Stabilization to promote Fish Passage associated with Headcut Stabilization**
   (a) **NMFS Hydro Fish Passage Review and Approve –** If headcut stabilization and channel spanning non-porous weirs create discrete longitudinal drops > 6", the BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf Refer to section "F" of this chapter.
   (b) Provide fish passage over stabilized headcut through constructed riffles for pool/riffle streams or a series of log or rock weir structures for step/pool channels. If large wood and boulder placement will be used for headcut stabilization, refer to activity category 2. Large Wood, Boulder, and Gravel Placement.
   (c) Construct weirs in a 'V' shape, oriented with the apex upstream, and lower in the center to direct flows to the middle of channel.
   (d) Key weirs into the stream bed to minimize structure undermining due to scour, preferably at least 2.5x their exposure height. The weir should also be keyed into both banks—if feasible greater than 8 feet.

(e) If several structures will be used in series, space the weirs at the appropriate distances to promote fish passage of all life stages of native fish. Incorporate state fish passage criteria (jump height, pool depth, etc.) in the design of weir structures. Recommended weir spacing should be no closer than the net drop divided by the channel slope (for example, a one-foot high weir in a stream with a two-percent gradient will have a minimum spacing of 50-feet [1/0.02]).

(f) Include fine material in the weir material mix to help seal the weir/channel bed, thereby preventing subsurface flow and ensuring fish passage immediately following construction if natural flows are sufficient.

(g) If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

c. **Fish Ladders**

i. **NMFS Hydro Fish Passage Review and Approve –** The BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf Refer to section "F" of this chapter.

ii. Fish ladders include in order of preference: the vertical slot ladder, the pool and weir ladder, the weir and orifice ladder, the pool-chute fish ladder, and other similar ladder types. See: NMFS Anadromous Salmonid Passage Facility Design (2011, or the most recent version) for guidelines and design criteria.

iii. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

d. **Irrigation Diversion Replacement/Relocation & Screen Installation/Replacement**

i. **NMFS Hydro Fish Passage Review and Approve** – The BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf Refer to section "F" of this chapter.

ii. Diversion structures—associated with points of diversion and future fish screens—must pass all life stages of T&E aquatic species that historically used the affected aquatic habitat.

iii. Water diversion intake and return points must be designed (to the greatest degree possible) to prevent all native fish life stages from swimming or being entrained into the diversion.

iv. NMFS fish screen criteria (NMFS 2011) applies to federally listed salmonid species under their jurisdiction as well as bull trout, Oregon chub, shortnose sucker, Lahontan cutthroat trout, Lost River sucker, Modoc sucker, and Warner sucker under FWS jurisdiction. Includes screens in temporary and permanent pump intakes.

v. All fish screens will be sized to match the irrigator's state water right or estimated historic water use, whichever is less.

vi. Size of bypass structure should be big enough to pass steelhead kelt and migratory bull trout back into the stream.

vii. Abandoned ditches and other similar structures will be plugged or backfilled, as appropriate, to prevent fish from swimming or being entrained into them.

viii. When making improvements to pressurized diversions, install a totalizing flow meter capable of measuring rate and duty of water use. For non-pressurized systems, install a staff gage or other measuring device capable of measuring instantaneous rate of water flow.

ix. Multiple existing diversions may be consolidated into one diversion as long as there is new instream construction or structures and if the consolidated diversion is located at the most downstream existing barrier.

x. Conversion of instream diversions to groundwater wells will only be used in circumstances where there is an agreement to ensure that any surface water made available for instream flows is protected from surface withdrawal by another water-user.

xi. For the removal of diversion structures constructed of local rock and dirt, the project sponsor will dispose of the removed material in the following manner:

(a) Material more than 60% silt or clay will be disposed in uplands, outside of the active floodplain.

(b) Material with more than 40% gravel will be deposited within the active floodplain, but not in wetlands.

(c) Material with more than 50% gravel and less than 30% fines (silt or clay) may be deposited below the OHWM.

2. **Large Wood, Boulder, and Gravel Placement** includes large wood (LW) and boulder placement, engineered logjams (ELJs), porous boulder weirs and vanes, gravel placement, and tree removal for LW projects. Such activities will occur in areas where channel structure is lacking due to past stream cleaning (LW removal), riparian timber harvest, and in areas where natural gravel supplies are low due to anthropogenic disruptions. These projects will occur in stream channels and adjacent floodplains to increase channel stability, rearing habitat, pool formation, spawning gravel deposition, channel complexity, hiding cover, low velocity areas, and floodplain function. Equipment such as helicopters, excavators, dump trucks, front-end loaders, full-suspension yarders, and similar equipment may be used to implement projects.

a. **Large Wood and Boulder Projects**

   i. Place LW and boulders in areas where they would naturally occur and in a manner that closely mimic natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low-gradient meadow streams.

   ii. Structure types shall simulate disturbance events to the greatest degree possible and include, but are not limited to, log jams, debris flows, wind-throw, and tree breakage.

   iii. No limits are to be placed on the size or shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage.

   iv. Projects can include grade control and bank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces.

   v. The partial burial of LW and boulders is permitted and may constitute the dominant means of placement. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired.

   vi. LW includes whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with rootwads should be a minimum of 1.5x bankfull channel width, while logs without rootwads should be a minimum of 2.0 x bankfull width.

   vii. Structures may partially or completely span stream channels or be positioned along stream banks.

   viii. Stabilizing or key pieces of LW must be intact, hard, with little decay, and if possible have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the large wood increases stability

   ix. Anchoring Large Wood – Anchoring alternatives may be used in preferential order:

      (a) use of adequate sized wood sufficient for stability
      (b) orient and place wood in such a way that movement is limited
      (c) ballast (gravel and/or rock) to increase the mass of the structure to resist movement
      (d) use of large boulders as anchor points for the LW
      (e) Pin LW with rebar to large rock to increase its weight. For streams that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (<12) an additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.

b. **Engineered Logjams (ELJs)** are structures designed to redirect flow and change scour and deposition patterns. To the extent practical, they are patterned after stable natural log jams and can be either unanchored or anchored in place using rebar, rock, or piles. Engineered log jams create a hydraulic shadow, a low-velocity zone downstream that allows sediment to settle out. Scour holes develop adjacent to the log jam. While providing valuable fish and wildlife habitat they also redirect flow and can provide stability to a streambank or downstream gravel bar.

i. **NMFS Hydro Fish Passage Review and Approve –** For non-porous ELJs that occupy >25% of the bankfull area, the BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf Refer to section "F" of this chapter.
ii. ELJs will be patterned, to the greatest degree possible, after stable natural log jams.
iii. Grade control ELJs are designed to arrest channel downcutting or incision by providing a grade control that retains sediment, lowers stream energy, and increases water elevations to reconnect floodplain habitat and diffuse downstream flood peaks.
iv. Stabilizing or key pieces of LW that will be relied on to provide streambank stability or redirect flows must be intact, solid (little decay). If possible, acquire LW with untrimmed rootwads to provide functional refugia habitat for fish.
v. When available, trees with rootwads attached should be a minimum length of 1.5 times the bankfull channel width, while logs without rootwads should be a minimum of 2.0 times the bankfull width.
vi. The partial burial of LW and boulders may constitute the dominant means of placement, and key boulders (footings) or LW can be buried into the stream bank or channel
vii. Angle and Offset – The LW portions of engineered log jam structures should be oriented such that the forces upon the large wood increases stability. If a rootwad is left exposed to the flow, the bole placed into the streambank should be oriented downstream parallel to the flow direction so the pressure on the rootwad pushes the bole into the streambank and bed. Wood members that are oriented parallel to flow are more stable than members oriented at 45 or 90 degrees to the flow.
viii. If LW anchoring is required, a variety of methods may be used. These include buttressing the wood between riparian trees, the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, such as rebar pinning or bolted connections, may be used. Rock may be used for ballast but is limited to that needed to anchor the LW.

c. **Porous Boulder Weirs and Vanes**

i. Full channel spanning boulder weirs are to be installed only in highly uniform, incised, bedrock-dominated channels to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reaches, etc.), where damage to infrastructure on public or private lands is of concern, or where private landowners will not allow log placements due to concerns about damage to their streambanks or property.

ii. Install boulder weirs low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.5-year flow event).
iii. Boulder weirs are to be placed diagonally across the channel or in more traditional upstream pointing "V" or "U" configurations with the apex oriented upstream.
iv. Boulder weirs are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. Plunges shall be kept less than 6" in height.
v. The use of gabions, cable, or other means to prevent the movement of individual boulders in a boulder weir is not allowed.
vi. Rock for boulder weirs shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used. Rock sizing depends on the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading.
vii. The project designer or an inspector experienced in these structures should be present during installation.
viii. Full spanning boulder weir placement should be coupled with measures to improve habitat complexity and protection of riparian areas to provide long-term inputs of LW.

d. **Gravel Augmentation**

i. Gravel can be placed directly into the stream channel, at tributary junctions, or other areas in a manner that mimics natural debris flows and erosion.
ii. Augmentation will only occur in areas where the natural supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate gravel accumulations in conjunction with other projects, such as simulated log jams and debris flows.
iii. Gravel to be placed in streams shall be a properly sized gradation for that stream, clean, and non-angular. When possible use gravel of the same lithology as found in the watershed. Reference the *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organism*s at Road-Stream Crossings (USFS 2008) to determine gravel sizes appropriate for the stream. This manual can be found at the following location: http://stream.fs.fed.us/fishxing/aop_pdfs.html
iv. Gravel can be mined from the floodplain at elevations above bankfull. Crushed rock is not permitted.
v. After gravel placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.
vi. Do not place gravel directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in redd destruction.
vii. Imported gravel must be free of invasive species and non-native seeds. If necessary, wash gravel prior to placement.

e. **Tree Removal for LW Projects**

i. Live conifers and other trees can be felled or pulled/pushed over in the RR, RHCAs, and upland areas (e.g., LSR, AMA, NSO/MaMu CH) for in-channel large wood placement only when conifers and trees are fully stocked. Tree felling shall not create excessive stream bank erosion or increase the likelihood of channel avulsion during high flows.

ii. Danger trees and trees killed through fire, insects, disease, blow-down and other means can be felled and used for in-channel placement regardless of live-tree stocking levels.

iii. Trees may be removed by cable, ground-based equipment, horses or helicopters.

iv. Trees may be felled or pushed/pulled directly into a stream and/or floodplain.

v. Trees may be stock piled for future instream restoration projects.

vi. The project manager for an aquatic restoration action under ARBA II will coordinate with an action-agency wildlife biologist in tree-removal planning efforts.

vii. In Northern Spotted Owl (NSO) and Marbled Murrelet (MAMU) habitat, meet the following requirements:

(a) PDC listed in II. H. 2. b. and c.

(b) The following Project Design Criteria applies to tree removal within the range of marbled murrelets (MAMU) and the northern spotted owl (NSO) in Douglas-fir dominated stands less than 80 years old that are not functioning as foraging habitat within a spotted owl home range nor do they contain murrelet nesting structure. It does not apply to tree selection in older stands or hardwood-dominated stands unless stated otherwise. The purpose of these criteria is to ensure that there would be no removal or adverse modification of suitable habitat for MAMU or NSO.

(i) A wildlife biologist must be fully involved in all tree-removal planning efforts, and be involved in making decisions on whether individual trees are suitable for nesting or have other important listed bird habitat value.

(ii) Trees can be removed to a level not less than a Relative Density (RD) of approximately 35, which is considered as fully occupying a site. This equates to approximately 60 trees per acre in the overstory and a tree spacing averaging 26 feet. Additionally 40% canopy cover would be maintained when in NSO or MAMU CH, when within 300 feet of occupied or unsurveyed murrelet nesting structure, and when dispersal habitat is limited in the area.

(iii) Trees to be removed can be live, hazard trees, or killed through fire, insects, disease, blow down and other means. Down trees and snags should only be removed if the stand will retain NWFP standards post removal.

(iv) Trees may be removed by cable, ground-based equipment, horses or helicopters, felled or pushed/pulled directly into a stream. Trees may be stock piled for future instream restoration projects.

(v) Tree species removed should be relatively common in the stand (i.e., not "minor" tree species).

(vi) Snags and trees with broad, deep crowns ("wolf" trees), damaged tops or other abnormalities that may provide a valuable wildlife habitat component should be reserved.

(vii) No gaps (openings) greater than 0.5 acre will be created in spotted owl CH. No gaps greater than ¼ acre will be created in murrelet CH. No gaps shall be created in Riparian Reserves that contain ESA-listed fish habitat.

(viii) The following Project Design Criteria applies to tree removal within the range of MAMU and the NSO in Douglas-fir dominated stands greater than 80 years old or that are functioning as foraging habitat within a NSO home range, and/or do contain MAMU nesting structure.

(a) Individual trees or small groups of trees should come from the periphery of permanent openings (roads etc.) or from the periphery of non-permanent openings (e.g., plantations, along recent clear-cuts etc.). Groups of trees greater than 4 trees shall 1) not be within MAMU suitable stands or stands buffering (300 ft.) MM suitable stands, 2) not be buffering (300 ft.) individual trees with MAMU nesting structure. A minimum distance of one potential tree height feet should be maintained between individual or group removals.

(b) Trees up to 36" dbh may be felled in any stands with agreement from a wildlife biologist that the trees are not providing MAMU nesting structures or providing cover for nest sites. No known NSO nest trees or alternate nest trees are to be removed. Potential NSO nest trees may only be removed in limited instances when it is confirmed with the wildlife biologist that nest trees will not be limited in the stand post removal.

(c) In order to minimize the creation of canopy gaps or edges, groups of adjacent trees selected should not create openings greater than ¼ acre within 0.5 miles of MAMU occupied habitat or when within murrelet CH. Within NSO CH, stands greater than 80 years old or within stands providing foraging habitat to NSO home ranges, gaps will be restricted to 0.5 acre openings or less. Gaps shall not be created in Riparian Reserves where ESA-listed fish occur.

3. **Dam, Tidegate and Legacy Structure Removal** includes removal of dams, tidegates, channel-spanning weirs, legacy habitat structures, earthen embankments, subsurface drainage features, spillway systems, outfalls, pipes, instream flow redirection structures (e.g., drop structure, gabion, groin), or similar devices used to control, discharge, or maintain water levels. Projects will be implemented to reconnect stream corridors, floodplains, and estuaries, reestablish wetlands, improve aquatic organism passage, and restore more natural channel and flow conditions. Any instream water control structures that impound

substantial amounts of contaminated sediment are not proposed. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. Dam Removal

i. **Design Review**

(a) **NMFS Hydro Fish Passage Review and Approve –** The BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf Refer to section "F" of this chapter.

(b) **Restoration Review Team (RRT) –** The BLM, FS and BIA will ensure that the action is individually reviewed by the RRT. Refer to section "G" of this chapter.

ii. Dams greater than 10-feet in height require a long-term monitoring and adaptive management plan that will be developed between the Services and the action agency.

iii. The Project Sponsor should provide the following information, plus any additional information requested:

(a) A longitudinal profile of the stream channel thalweg for 20 channel widths downstream of the structure and 20 channel widths upstream of the reservoir area (outside of the influence of the structure) shall be used to determine the potential for channel degradation.

(b) A minimum of three cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area (outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment.

(c) Sediment characterization to determine the proportion of coarse sediment (>2mm) in the reservoir area.

(d) A survey of any downstream spawning areas that may be affected by sediment released by removal of the water control structure or dam. Reservoirs with a d35 greater than 2 mm (i.e.,, 65% of the sediment by weight exceeds 2 mm in diameter) may be removed without excavation of stored material, if the sediment contains no contaminants; reservoirs with a d35 less than 2 mm (i.e.,, 65% of the sediment by weight is less than 2 mm in diameter) will require partial removal of the fine sediment to create a pilot channel, in conjunction with stabilization of the newly exposed streambanks with native vegetation.

iv. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

b. **Tide Gate Removal –** This action includes the removal of tide gates.

   i. **NMFS Hydro Fish Passage Review and Approve –** For projects that constrain tidal exchange, the BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf Refer to section "F" of this chapter.

   ii. Follow II. C. Work Area Isolation & Fish Capture and Release. If a culvert or bridge will be constructed at the location of a removed tide gate, then the structure should be large enough to allow for a full tidal exchange.

c. **Removal of Legacy Structures –** This action includes the removal of past projects**,** such as large wood, boulder, rock gabions, and other in-channel and floodplain structures.

   i. If the structure being removed contains material (i.e., large wood, boulders, concrete, etc.) not typically found within the stream or floodplain at that site, remove material from the 100-year floodplain.

   ii. If the structure being removed contains material (i.e., large wood, boulders, etc.) that is typically found within the stream or floodplain at that site, the material can be reused to implement habitat improvements described under Large Wood, Boulder, and Gravel Placement activity category in this ARBA II.

   iii. If the structure being removed is keyed into the bank, fill in "key" holes with native materials to restore contours of stream bank and floodplain. Compact the fill material adequately to prevent washing out of the soil during over-bank flooding. Do not mine material from the stream channel to fill in "key" holes.

   iv. When removal of buried log structures may result in significant disruption to riparian vegetation and/or the floodplain, consider using a chainsaw to extract the portion of log within the channel and leaving the buried sections within the streambank.

   v. If a project involves the removal of multiple barriers on one stream or in one watershed over the course of a work season, remove the most upstream barrier first if possible.

   vi. If the legacy structures (log, rock, or gabion weirs) were placed to provide grade control, evaluate the site for potential headcutting and incision due to structure removal. If headcutting and channel incision are likely to occur due to structure removal, additional measures must be taken to reduce these impacts.

   vii. If the structure is being removed because it has caused an over-widening of the channel, consider implementing other ARBAII restoration categories to decrease the width to depth ratio of the stream to a level commensurate with the geomorphic setting.

4. **Channel Reconstruction/Relocation** projects include reconstruction of existing stream channels through excavation and structure placement (LW and boulders) or relocation (rerouting of flow) into historic or newly constructed channels that are typically more sinuous and complex. This proposed action applies to stream systems that have been straightened, channelized, dredged, or otherwise modified for the purpose of flood control, increasing arable land, realignment, or other land use management goals or for streams that are incised or otherwise disconnected from their floodplains resulting from watershed disturbances. This activity type will be implemented to improve aquatic and riparian habitat diversity and complexity, reconnect stream channels to floodplains, reduce bed and bank erosion, increase hyporheic exchange, provide long-term nutrient storage, provide substrate for macroinvertebrates, moderate flow disturbance, increase retention of organic material, and provide refuge for fish and other aquatic species. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.
   a. **General Project Design Criteria**
      i. **Design Review**
         (a) **NMFS Hydro Fish Passage Review and Approve –** The BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf Refer to section "F" of this chapter.
         (b) **Restoration Review Team (RRT) –** The BLM, FS and BIA will ensure that the action is individually reviewed by the RRT. Refer to section "G" of this chapter.
      ii. Design Guidance
         (a) Construct geomorphically appropriate stream channels and floodplains within a watershed and reach context.
         (b) Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.
         (c) To the greatest degree possible, remove nonnative fill material from the channel and floodplain to an upland site.
         (d) When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain where appropriate to support the project goals and objectives.
         (e) Structural elements shall fit within the geomorphic context of the stream system. For bed stabilization and hydraulic control structures, constructed riffles shall be preferentially used in pool-riffle stream types, while roughened channels and boulder weirs shall be preferentially used in step-pool and cascade stream types.
         (f) Material selection (large wood, rock, gravel) shall also mimic natural stream system materials.

(g) Construction of the streambed should be based on Stream Simulation Design principles as described in Section 6.2 of the 2008 Forest Service document *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* or other appropriate design guidance documents.

b. **Project Documentation** – Prior to the Design Review, the project contact will provide the NMFS' Habitat Conservation Division and RRT with the following documentation:
   i. Background and Problem Statement
      (a) Site history
      (b) Environmental baseline
      (c) Problem Description
      (d) Cause of problem
   ii. Project Description
      (a) Goals/objectives
      (b) Project elements
      (c) Sequencing, implementation
      (d) Recovery trajectory –how does it develop and evolve?
   iii. Design Analysis
      (a) technical analyses,
      (b) computations relating design to analysis,
      (c) references
   iv. River Restoration Analysis Tool – The River Restoration Analysis Tool (restorationreview.com) was created to assist with design and monitoring of aquatic restoration projects. The following questions taken from the tool must be addressed in the project documentation:
      (a) Problem Identification
         (i) Is the problem identified?
         (ii) Are causes identified at appropriate scales?
      (b) Project Context
         (i) Is the project identified as part of a plan, such as a watershed action plan or recovery plan?
         (ii) Does the project consider ecological, geomorphic, and socioeconomic context?
      (c) Goals & Objectives
         (i) Do goals and objectives address problem, causes, and context?
         (ii) Are objectives measurable?
      (d) Alternatives/Options Evaluation
      (a) Were alternatives/options considered?
      (b) Are uncertainties and risk associated with selected alternative acceptable?
      (e) Project Design
         (i) Do project elements collectively support project objectives?
         (ii) Are design criteria defined for all project elements?
         (iii) Do project elements work with stream processes to create and maintain habitat?
         (iv) Is the technical basis of design sound for each project element?

(f) Implementation
   (i) Are plans and specifications sufficient in scope and detail to execute the project?
   (ii) Does plan address potential implementation impacts and risks?
(g) Monitoring & Management
   (i) Does monitoring plan address project compliance?
   (ii) Does monitoring plan directly measure project effectiveness?

c. **Monitoring –** Develop a monitoring and adaptive plan that has been reviewed and approved by the RRT and the Services. The plan will include the following:
   i. Introduction
   ii. Existing Monitoring Protocols
   iii. Project Effectiveness Monitoring Plan
   iv. Project Review Team Triggers
   v. Monitoring Frequency, Timing, and Duration
   vi. Monitoring Technique Protocols
   vii. Data Storage and Analysis
   viii. Monitoring Quality Assurance Plan
   ix. Literature cited

5. **Off- and Side-Channel Habitat Restoration** projects will be implemented to reconnect historic side-channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features. This activity category typically applies to areas where side channels, alcoves, and other backwater habitats have been filled or blocked from the main channel, disconnecting them from most if not all flow events. These project types will increase habitat diversity and complexity, improve flow heterogeneity, provide long-term nutrient storage and substrate for aquatic macroinvertebrates, moderate flow disturbances, increase retention of leaf litter, and provide refuge for fish during high flows. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.
   a. **NMFS Hydro Fish Passage Review and Approve –** When a proposed side channel will contain >20% of the bankfull flow, the BLM, FS and BIA will ensure that the action is individually reviewed by the Portland office of the NMFS' Habitat Conservation Division for consistency with criteria in NMFS (2011). Refer to section "F" of this chapter.
   b. **Data Requirements** – Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation.
   c. **Allowable Excavation –** Off- and side-channel improvements can include minor excavation ($\leq$ 10% of volume) of naturally accumulated sediment within historical channels. There is no limit as to the amount of excavation of anthropogenic fill within historic side channels as long as such channels can be clearly identified through field and/or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel.

Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.

6. **Streambank Restoration** will be implemented through bank shaping and installation of coir logs or other soil reinforcements as necessary to support riparian vegetation; planting or installing large wood, trees, shrubs, and herbaceous cover as necessary to restore ecological function in riparian and floodplain habitats; or a combination of the above methods. Such actions are intended to restore banks that have been altered through road construction, improper grazing, invasive plants, and more. Benefits include increased amounts of riparian vegetation and associated shading, bank stability, and reduced sedimentation into stream channels and spawning gravels. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.
   a. Without changing the location of the bank toe, restore damaged streambanks to a natural slope and profile suitable for establishment of riparian vegetation. This may include sloping of unconsolidated bank material to a stable angle of repose or the use of benches in consolidated, cohesive soils.
   b. Complete all soil reinforcement earthwork and excavation in the dry. When necessary, use soil layers or lifts that are strengthened with biodegradable fabrics and penetrable by plant roots.
   c. Include large wood to the extent it would naturally occur. If possible, large wood should have untrimmed root wads to provide functional refugia habitat for fish. Wood that is already within the stream or suspended over the stream may be repositioned to allow for greater interaction with the stream.
   d. Rock will not be used for streambank restoration, except as ballast to stabilize large wood.
   e. Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, etc.
   f. Do not apply surface fertilizer within 50 feet of any stream channel.
   g. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
   h. Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.

7. **Set-back or Removal of Existing Berms, Dikes, and Levees** will be conducted to reconnect historic fresh-water deltas to inundation, stream channels with floodplains, and historic estuaries to tidal influence as a means to increase habitat diversity and complexity, moderate flow disturbances, and provide refuge for fish during high flows. Other restored ecological functions include overland flow during flood events, dissipation of flood energy, increased water storage to augment low flows, sediment and debris deposition, growth of riparian vegetation, nutrient cycling, and development of side channels and alcoves. Such projects will take place where estuaries and floodplains have been disconnected

from adjacent rivers through drain pipes and anthropogenic fill. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. Floodplains and Freshwater Deltas

i. Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.

ii. Remove drain pipes, fences, and other capital projects to the extent possible.

iii. To the extent possible, remove nonnative fill material from the floodplain to an upland site.

iv. Where it is not possible to remove or set-back all portions of dikes and berms, or in areas where existing berms, dikes, and levees support abundant riparian vegetation, openings will be created with breaches. Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion during flood events. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project and/or at the lowest elevation of the floodplain to ensure the flows will naturally recede back into the main channel thus minimizing fish entrapment.

v. Elevations of dike/levee setbacks shall not exceed the elevation of removed structures

vi. When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain to create set-back dikes and fill anthropogenic holes provided that floodplain function is not impeded.

b. Estuary Restoration

i. Project implementation shall be conducted in a sequence that will not preclude repairing or restoring estuary functions once dikes/levees are breached and the project area is flooded.

ii. Culverts and tide gates will be removed using the design criteria and conservation measures, where appropriate, as described in II. C. Work Area Isolation & Fish Capture and Release and under the Fish Passage Restoration category.

iii. Roads within the project area should be removed to allow free flow of water. Material either will be placed in a stable area above the ordinary high water line or highest measured tide or be used to restore topographic variation in wetlands.

iv. To the extent possible, remove segmented drain tiles placed to drain wetlands. Fill generated by drain tile removal will be compacted back into the ditch created by removal of the drain tile.

v. Channel construction may be done to recreate channel morphology based on aerial photograph interpretation, literature, topographic surveys, and nearby undisturbed channels. Channel dimensions (width and depth) are based on measurements of similar types of channels and the drainage area.

In some instances, channel construction is simply breaching the levee. For these sites, further channel development will occur through natural processes. When required, use PDC in the Channel Reconstruction/Relocation category.

vi. Fill ditches constructed and maintained to drain wetlands. Some points in an open ditch may be over-filled, while other points may be left as low spots to enhance topography and encourage sinuosity of the developing channel.

8. **Reduction/Relocation of Recreation Impacts** is intended to close, better control, or relocate recreation infrastructure and use along streams and within riparian areas. This includes removal, improvement, or relocation of infrastructure associated with designated campgrounds, dispersed camp sites, day-use sites, foot trails, and off-road vehicle (ORV) roads/trails in riparian areas. The primary purpose is to eliminate or reduce recreational impacts to restore riparian areas and vegetation, improve bank stability, and reduce sedimentation into adjacent streams. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.
   a. Design remedial actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.
   b. To the extent possible, non-native fill material shall be removed from the floodplain to an upland site.
   c. Overburden or fill comprised of native materials, which originated from the project area, can be used to reshape the floodplain, placed in small mounds on the floodplain, used to fill anthropogenic holes, buried on site, and/or disposed into upland areas.
   d. For recreation relocation projects—such as campgrounds, horse corrals, ORV trails—move current facilities out of the riparian area or as far away from the stream as possible.
   e. Consider de-compaction of soils and vegetation planting once overburden material is removed.
   f. Place barriers—boulders, fences, gates, etc.—outside of the bankfull width and across traffic routes to prevent ORV access into and across streams.
   g. For work conducted on ORV roads and trails, follow relevant PDC in the Road and Trail Erosion Control and Decommissioning category.

9. **Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering Facilities** projects will be implemented by constructing fences to exclude riparian grazing, providing controlled access for walkways that livestock use to transit across streams and through riparian areas, and reducing livestock use in riparian areas and stream channels by providing upslope water facilities. Such projects promote a balanced approach to livestock use in riparian areas, reducing livestock impacts to riparian soils and vegetation, streambanks, channel substrates, and water quality. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. Livestock Fencing

i. Fence placement should allow for lateral movement of a stream and to allow establishment of riparian plant species**.** To the extent possible, fences will be placed outside the channel migration zone.

ii. Minimize vegetation removal, especially potential large wood recruitment sources, when constructing fence lines.

iii. Where appropriate, construct fences at water gaps in a manner that allows passage of large wood and other debris.

b. Livestock Stream Crossings

i. The number of crossings will be minimized.

ii. Locate crossings or water gaps where streambanks are naturally low. Livestock crossings or water gaps must not be located in areas where compaction or other damage can occur to sensitive soils and vegetation (e.g., wetlands) due to congregating livestock.

iii. To the extent possible, crossings will not be placed in areas where ESA-listed species spawn or are suspected of spawning (e.g., pool tailouts where spawning may occur), or within 300-feet upstream of such areas.

iv. Existing access roads and stream crossings will be used whenever possible, unless new construction would result in less habitat disturbance and the old trail or crossing is retired.

v. Access roads or trails will be provided with a vegetative buffer that is adequate to avoid or minimize runoff of sediment and other pollutants to surface waters.

vi. Essential crossings will be designed and constructed or improved to handle reasonably foreseeable flood risks, including associated bedload and debris, and to prevent the diversion of streamflow out of the channel and down the trail if the crossing fails.

vii. If necessary, the streambank and approach lanes can be stabilized with native vegetation and/or angular rock to reduce chronic sedimentation. The stream crossing or water gap should be armored with sufficient sized rock (e.g., cobble-size rock) and use angular rock if natural substrate is not of adequate size.

viii. Livestock crossings will not create barriers to the passage of adult and juvenile fish. Whenever a culvert or bridge—including bridges constructed from flatbed railroad cars, boxcars, or truck flatbeds—is used to create the crossing, the structure width will tier to project design criteria listed for Stream Simulation Culvert and Bridge Projects under the Fish Passage Restoration category.

ix. Stream crossings and water gaps will be designed and constructed to a width of 10 to 15 feet in the upstream-downstream direction to minimize the time livestock will spend in the crossing or riparian area.

x. When using pressure treated lumber for fence posts, complete all cutting/drilling offsite (to the extent possible) so that treated wood chips and debris do not enter water or flood prone areas.

xi. Riparian fencing is not to be used to create livestock handling facilities or riparian pastures.

c. **Off-channel livestock watering facilities**

   i. The development of a spring is not allowed if the spring is occupied by ESA-listed species.
   ii. Water withdrawals must not dewater habitats or cause low stream flow conditions that could affect ESA-listed fish. Withdrawals may not exceed 10% of the available flow.
   iii. Troughs or tanks fed from a stream or river must have an existing valid water right. Surface water intakes must be screened to meet the most recent version of NMFS fish screen criteria (*NOAA Fisheries Anadromous Salmonid Passage Facility Design* (NMFS 2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf), be self-cleaning, or regularly maintained by removing debris buildup. A responsible party will be designated to conduct regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning.
   iv. Place troughs far enough from a stream or surround with a protective surface to prevent mud and sediment delivery to the stream. Avoid steep slopes and areas where compaction or damage could occur to sensitive soils, slopes, or vegetation due to congregating livestock.
   v. Ensure that each livestock water development has a float valve or similar device, a return flow system, a fenced overflow area, or similar means to minimize water withdrawal and potential runoff and erosion.
   vi. Minimize removal of vegetation around springs, wet areas.
   vii. When necessary, construct a fence around the spring development to prevent livestock damage.

10. **Piling and other Structure Removal** includes the removal of untreated and chemically treated wood pilings, piers, boat docks as well as similar structures comprised of plastic, concrete, and other material. Piling and other structure removal from waterways will improve water quality by eliminating chronic sources of toxic contamination and associated impacts to riparian dependent species. Pilings and other structures occur in estuaries, lakes, and rivers and are typically used in association with boat docks and other facilities. Equipment such as boats, barges, excavators, dump trucks, front-end loaders, and similar equipment may be used to implement projects.

a. **When removing an intact pile**

   i. Install a floating surface boom to capture floating surface debris.
   ii. To the extent possible, keep all equipment (e.g., bucket, steel cable, vibratory hammer) out of the water, grip piles above the waterline, and complete all work during low water and low current conditions.
   iii. Dislodge the piling with a vibratory hammer, whenever feasible. Never intentionally break a pile by twisting or bending.
   iv. Slowly lift piles from the sediment and through the water column.
   v. Place chemically-treated piles in a containment basin on a barge deck, pier, or shoreline without attempting to clean or remove any adhering sediment. A containment basin for the removed piles and any adhering sediment may be constructed of durable plastic sheeting with sidewalls

supported by hay bales or another support structure to contain all sediment.

vi. Fill the holes left by each piling with clean, native sediments located from the project area.

vii. Dispose of all removed piles, floating surface debris, any sediment spilled on work surfaces, and all containment supplies at a permitted upland disposal site.

b. **When removing a broken pile**

i. If a pile breaks above the surface of uncontaminated sediment, or less than 2 feet below the surface, every attempt short of excavation will be made to remove it entirely. If the pile cannot be removed without excavation, excavate sediments and saw the stump off at least 3 feet below the surface of the sediment.

ii. If a pile breaks above contaminated sediment, saw the stump off at the sediment line; if a pile breaks within contaminated sediment, make no further effort to remove it and cover the hole with a cap of clean substrate appropriate for the site.

iii. If dredging is likely in the area of piling removal, use a global positioning device (GPS) to note the location of all broken piles for future use in site debris characterization.

11. **In-channel Nutrient Enhancement** includes the placement of salmon carcasses, carcass analogs (processed fish cakes), or inorganic fertilizers in stream channels to help return stream nutrient levels back to historic levels. This action helps restore marine-derived nutrients to aquatic systems, thereby adding an element to the food chain that is important for growth of macroinvertebrates, juvenile salmonids, and riparian vegetation. Application and distribution of nutrients throughout a stream corridor can occur from bridges, stream banks, boats, or helicopter.

    a. In Oregon, projects are permitted through ODEQ. Use carcasses from the treated watershed or those that are certified disease free by an ODFW pathologist.
    b. In Washington, follow WDFW's *Protocols and Guidelines for Distributing Salmonid Carcasses, Salmon Carcass Analogs, and Delayed Release Fertilizers to Enhance Stream Productivity in Washington State, 2004* or most recent edition.
    c. Ensure that the relevant streams have the capacity to capture and store placed carcasses.
    d. Carcasses should be of species native to the watershed and placed during the normal migration and spawning times that would naturally occur in the watershed.
    e. Do not supplement nutrients in eutrophic or naturally oligotrophic systems.

12. **Road and Trail Erosion Control and Decommissioning** includes hydrologically closing or decommissioning roads and trails, including culvert removal in perennial and intermittent streams; removing, installing or upgrading cross-drainage culverts; upgrading culverts on non fish-bearing steams; constructing water bars and dips; reshaping road prisms; vegetating fill and cut slopes; removing and stabilizing of side-cast materials; grading or resurfacing roads that have been improved for aquatic restoration with gravel, bark chips, or other permeable materials; contour shaping of the road or trail base; removing road fill to native soils; soil stabilization and tilling compacted surfaces to reestablish native vegetation. This category also includes programmatic/public notice road closures under FS and BLM/BIA equivalent Travel and Access Management Plans. Such actions will target priority roads that contribute sediment to streams, block fish passage, and/or disrupt floodplain and riparian functions. Equipment such as excavators, bull dozers, dump trucks, front-end loaders, and similar equipment may be used to implement projects.
    a. **Road Decommissioning and Stormproofing**
        i. For road decommissioning and hydrologic closure projects within riparian areas, recontour the affected area to mimic natural floodplain contours and gradient to the extent possible.
        ii. When obliterating or removing segments immediately adjacent to a stream, consider using sediment control barriers between the project and stream.
        iii. Dispose of slide and waste material in stable sites out of the flood-prone area. Native material may be used to restore natural or near-natural contours.
        iv. Drainage features used for stormproofing and treatment projects should be spaced as to hydrologically disconnect road surface runoff from stream channels. If grading and resurfacing is required, use gravel, bark, or other permeable materials for resurfacing.
        v. Minimize disturbance of existing vegetation in ditches and at stream crossings.
        vi. Conduct activities during dry-field conditions (generally May 15 to October 15) when the soil is more resistant to compaction and soil moisture is low.
        vii. When removing a culvert from a first or second order, non-fishing bearing stream, project specialists shall determine if culvert removal should include stream isolation and rerouting in project design. Culvert removal on fish bearing streams shall adhere to the measures described in the Fish Passage Restoration activity category.
        viii. For culvert removal projects, restore natural drainage patterns and channel morphology. Evaluate channel incision risk and construct in-channel grade control structures when necessary.
    b. **Road Relocation**
        i. When a road is decommissioned in a floodplain and future vehicle access through the area is still required, relocate the road as far as practical away from the stream.

ii. The relocation will not increase the drainage network and will be constructed to hydrologically disconnect it from the stream network to the extent practical. New cross drains shall discharge to stable areas where the outflow will quickly infiltrate the soil and not develop a channel to a stream.
iii. This consultation does not cover new road construction (not associated with road relocation) or routine maintenance within riparian areas.

13. Non-native Invasive Plant Control includes manual, mechanical, biological, and chemical methods to remove invasive non-native plants within Riparian Reserves, Riparian Habitat Conservation Areas, or equivalent and adjacent uplands. In monoculture areas (e.g., areas dominated by black berry or knotweed) heavy machinery can be used to help remove invasive plants. This activity is intended to improve the composition, structure, and abundance of native riparian plant communities important for bank stability, stream shading, large wood and other organic inputs into streams, all of which are important elements to fish habitat and water quality. Manual and hand-held equipment will be used to remove plants and disperse chemical treatments. Heavy equipment, such as bulldozers, can be used to remove invasive plants, primarily in areas with low slope values. (Invasive plant treatments included in this ARBA II are to serve BLM, FS and BIA administrative units until such units complete a local or provincial consultation for this activity type.)

a. **Project Extent** – Non-native invasive plant control projects will not exceed 10% of acres with a RR (NWFP) or RHCA (PACFISH / INFISH) within a 6^{th} HUC/year.
b. **Manual Methods** – Manual treatments are those done with hand tools or hand held motorized equipment. These treatments typically involve a small group of people in a localized area. Vegetation disturbance varies from cutting or mowing to temporarily reduce the size and vigor of plants to removal of entire plants. Soil disturbance is minimized by managing group size and targeting individual plants.
c. **Mechanical Methods** – Mechanical treatments involve the use of motorized equipment and vary in intensity and impact from mowing to total vegetation removal and soil turnover (plowing and seed bed preparation). Mechanical treatments reduce the number of people treating vegetation. Unintended impacts may vary from none to removal of non-target vegetation and soil compaction or erosion. Impacts could be lessened by minimizing the use of heavy equipment in riparian areas, avoiding treatments that create bare soil in large or extensive areas, reseeding and mulching following treatments, and avoiding work when soils are wet and subject to compaction.
d. **Biological Methods** – Release of traditional host specific biological control agents (insects and pathogens) consists of one or two people depositing agents on target vegetation. This results in minimal impact to soils and vegetation from the actual release. Over time, successful biological control agents will reduce the size and vigor of host noxious weeds with minimal or no impact to other plant species. Targeted grazing to reduce size and vigor of invasive plants, may impact desirable vegetation and soils. Short duration, high density

stocking is typically used for treatments 1 to 3 times per year. Targeted grazing would be timed to impact invasive species while minimizing undesirable impacts.

e. **Chemical Methods –** Invasive plants, including state-listed noxious weeds, are particularly aggressive and difficult to control and may require the use of herbicides for successful control and restoration of riparian and upland areas. Herbicide treatments vary in impact to vegetation from complete removal to reduced vigor of specific plants. Minimal impacts to soil from compaction and erosion are expected.

   i. General Guidance

      (a) Use herbicides only in an integrated weed or vegetation management context where all treatments are considered and various methods are used individually or in concert to maximize the benefits while reducing undesirable effects.

      (b) Carefully consider herbicide impacts to fish, wildlife, non-target native plants, and other resources when making herbicide choices.

      (c) Treat only the minimum area necessary for effective control. Herbicides may be applied by selective, hand-held, backpack, or broadcast equipment in accordance with state and federal law and only by certified and licensed applicators to specifically target invasive plant species.

      (d) Herbicide application rates will follow label direction, unless site-specific analysis determines a lower maximum rate is needed to reduce non-target impacts.

      (e) A herbicide safety/spill response plan is required for all projects to reduce the likelihood of spills, misapplication, reduce potential for unsafe practices, and to take remedial actions in the event of spills. Spill plan contents will follow agency direction.

      (f) Pesticide applicator reports must be completed within 24 hours of application.

   ii. **Herbicide Active Ingredients** – Active ingredients are restricted to the following (some common trade names are shown in parentheses; use of trade names does not imply endorsement by the US government):

      (a) aminopyralid (e.g., *terrestrial*: Milestone VM)
      (b) chlorsulfuron (e.g., *terrestrial*: Telar, Glean, Corsair)
      (c) clopyralid (e.g., *terrestrial*: Transline)
      (d) dicamba (e.g., *terrestrial*: Vanquish, Banvel)
      (e) diflufenzopyr + dicamba (e.g., *terrestrial*: Overdrive)
      (f) glyphosate (e.g., *aquatic*: Aquamaster, AquaPro, Rodeo, Accord)
      (g) imazapic (e.g., *terrestrial*: Plateau)
      (h) imazapyr (e.g., *aquatic*: Habitat; *terrestrial*: Arsenal, Chopper)
      (i) metsulfuron methyl (e.g., *terrestrial*: Escort)
      (j) picloram (e.g., *terrestrial*: Tordon, Outpost 22K)
      (k) sethoxydim (e.g., *terrestrial*: Poast, Vantage)
      (l) sulfometuron methyl (e.g., *terrestrial*: Oust, Oust XP)
      (m) triclopyr (e.g., *aquatic*: Garlon 3A, Tahoe 3A, Renovate 3, Element 3A; *terrestrial*: Garlon 4A, Tahoe 4E, Pathfinder II)

(n) 2,4-D (e.g., *aquatic*: 2,4-D Amine, Clean Amine; *terrestrial*: Weedone, Hi-Dep)

iii. **Herbicide Adjuvants –** When recommended by the label, an approved aquatic surfactant would be used to improve uptake. When aquatic herbicides are required, the only surfactants and adjuvants permitted are those allowed for use on aquatic sites, as listed by the Washington State Department of Ecology: http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html. (Oregon Department of Agriculture also often recommends this list for aquatic site applications). The surfactants R-11, Polyethoxylated tallow amine (POEA), and herbicides that contain POEA (e.g., Roundup) will not be used.

iv. **Herbicide Carriers –** Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil.

v. **Herbicide Mixing –** Herbicides will be mixed more than 150 feet from any natural waterbody to minimize the risk of an accidental discharge. Impervious material will be placed beneath mixing areas in such a manner as to contain any spills associated with mixing/refilling. Spray tanks shall be washed further than 300 feet away from surface water. All hauling and application equipment shall be free from leaks and operating as intended.

vi. **Herbicide Application Methods –** Liquid forms of herbicides will be applied as follows:

(a) Broadcast spraying using booms mounted on ground-based vehicles (this consultation does not include aerial applications).

(b) Spot spraying with hand held nozzles attached to back pack tanks or vehicles and hand-pumped sprayers to apply herbicide directly onto small patches or individual plants.

(c) Hand/selective through wicking and wiping, basal bark, frill ("hack and squirt"), stem injection, or cut-stump.

(d) Dyes or colorants, (e.g., Hi-Light, Dynamark) will be used to assist in treatment assurance and minimize overspraying within 100 feet of live water.

vii. **Minimization of Herbicide Drift and Leaching –** Herbicide drift and leaching will be minimized as follows:

(a) Do not spray when wind speeds exceed 10 miles per hour to reduce the likelihood of spray/dust drift. Winds of 2 mph or less are indicative of air inversions. The applicator must confirm the absence of an inversion before proceeding with the application whenever the wind speed is 2 mph or less.

(b) Be aware of wind directions and potential for herbicides to affect aquatic habitat area downwind.

(c) Keep boom or spray as low as possible to reduce wind effects.

(d) Avoid or minimize drift by utilizing appropriate equipment and settings (e.g., nozzle selection, adjusting pressure, drift reduction agents, etc.). Select proper application equipment (e.g., spray equipment that produces 200-800 micron diameter droplets [Spray droplets of 100 microns or less are most prone to drift]).

(e) Follow herbicide label directions for maximum daytime temperature permitted (some types of herbicides volatilize in hot temperatures).
(f) Do not spray during periods of adverse weather conditions (snow or rain imminent, fog, etc.). Wind and other weather data will be monitored and reported for all pesticide applicator reports.
(g) Herbicides shall not be applied when the soil is saturated or when a precipitation event likely to produce direct runoff to fish-bearing waters from a treated site is forecasted by NOAA/NWS (National Weather Service) or other similar forecasting service within 48 hours following application. Soil-activated herbicides can be applied as long as label is followed. Do not conduct any applications during periods of heavy rainfall.

viii. **Herbicide buffer distances –** The following no-application buffers—which are measured in feet and are based on herbicide formula, stream type, and application method—will be observed during herbicide applications (Table 6). Herbicide applications based on a combination of approved herbicides will use the most conservative buffer for any herbicide included. Buffer widths are measured as map distance perpendicular to the bankfull for streams, the upland boundary for wetlands, or the upper bank for roadside ditches.

Table 6 – No-Application Buffer Width in Feet for Herbicide Application, by Stream Type and Application Method						
Herbicide	Perennial Streams and Wetlands, and Intermittent Streams and Roadside Ditches with flowing or standing water present			Dry Intermittent Streams, Dry Intermittent Wetlands, Dry Roadside Ditches		
	Broadcast Spraying	Spot Spraying	Hand Selective	Broadcast Spraying	Spot Spraying	Hand Selective
Labeled for Aquatic Use						
aquatic glyphosate	100	waterline	waterline	50	0	0
aquatic imazapyr	100	waterline	waterline	50	0	0
aquatic triclopyr-TEA	**Not Allowed**	15	waterline	**Not Allowed**	0	0
aquatic 2,4-D (amine)	100	waterline	waterline	50	0	0
Low Risk to Aquatic Organisms						
Aminopyralid	100	waterline	waterline	50	0	0
Dicamba	100	15	15	50	0	0
Dicamba+diflufenzopyr	100	15	15	50	0	0
Imazapic	100	15	bankfull elevation	50	0	0
Clopyralid	100	15	bankfull elevation	50	0	0
metsulfuron-methyl	100	15	bankfull elevation	50	0	0
Moderate Risk to Aquatic Organisms						
Imazapyr	100	50	bankfull elevation	50	15	bankfull elevation
sulfometuron-methyl	100	50	5	50	15	bankfull elevation
Chlorsulfuron	100	50	bankfull elevation	50	15	bankfull elevation
High Risk to Aquatic Organisms						
Triclopyr-BEE	**Not Allowed**	150	150	**Not Allowed**	150	150
Picloram	100	50	50	100	50	50
Sethoxydim	100	50	50	100	50	50
2,4-D (ester)	100	50	50	100	50	50

14. **Juniper Tree Removal** will be conducted in riparian areas and adjoining uplands to help restore plant species composition and structure that would occur under natural fire regimes. Juniper removal will occur in those areas where juniper have encroached into riparian areas as a result of fire exclusion, thereby replacing more desired riparian plant species such as willow, cottonwood, aspen, alder, sedge, and rush. This action will help restore composition and structure of desired riparian species, thereby improving ground cover and water infiltration into soils. Equipment may include chainsaws, pruning shears, winch machinery, feller-bunchers, and slash-busters
    a. Remove juniper to natural stocking levels where BLM and FS determines that juniper trees are expanding into neighboring plant communities to the detriment of other native riparian vegetation, soils, or streamflow.
    b. Do not cut old-growth juniper, which typically has several of the following features: sparse limbs, dead limbed or spiked-tops, deeply furrowed and fibrous bark, branches covered with bright-green arboreal lichens, noticeable decay of cambium layer at base of tree, and limited terminal leader growth in upper branches (Miller *et al*. 2005).
    c. Felled trees may be left in place, lower limbs may be cut and scattered, or all or part of the trees may be used for streambank or wetland restoration (e.g., manipulated as necessary to protect riparian or wetland shrubs from grazing by livestock or wildlife or otherwise restore ecological function in floodplain, riparian, and wetland habitats).
    d. Where appropriate, cut juniper may be placed into stream channels and floodplains to provide aquatic benefits. Juniper can be felled or placed into the stream to promote channel aggradation as long as such actions do not obstruct fish movement and use of spawning gravels or increase width to depth ratios.
    e. On steep and/or south-facing slopes, where ground vegetation is sparse, leave felled juniper in sufficient quantities to promote reestablishment of vegetation and prevent erosion.
    f. If seeding is a part of the action, consider whether seeding would be most appropriate before or after juniper treatment.
    g. When using feller-buncher and slash-buster equipment, operate equipment in a manner that minimizes soil compaction and disturbance to soils and native vegetation to the extent possible. Equipment exclusion areas (buffer area along stream channels) should be as wide as the feller-buncher or slash-buster arm.

15. **Riparian Vegetation Treatment (controlled burning)** includes reintroduction of low- and moderate-severity fire into riparian areas to help restore plant species composition and structure that would occur under natural fire regimes. This activity is permitted in dry forest types east of the Cascade mountain crest and southwestern Oregon. Further, this can be applied to more localized fire-dependent ecosystems, such as oak woodlands, west of the Cascade mountain crest. Conifer thinning may be required to adjust fuel loads for moderate-severity burns to regenerate deciduous trees and shrubs. Resulting benefits include restoration of desired levels of stream shade, bank stability, soil erosion and

stream turbidity, stream nutrients, and/or large wood inputs. Additional benefits include maintenance of late-seral (old-growth) trees which serve as sources of large wood to streams. Equipment would include drip torches and chainsaws, along with fire suppression vehicles and equipment.

a. **Low and Moderate Severity Burns**

   i. Experienced fuels specialists, silviculturists, fisheries biologist, and hydrologists shall be involved in designing prescribed burn treatments.

   ii. Prescriptions will focus on restoring the plant species composition and structure that would occur under natural fire regimes.

   iii. Burn plans are required for each action and shall include, but not be limited to the following: a description of existing and desired future fire classifications, existing and target stand structure and species composition (including basis for target conditions); other ecological objectives, type, severity, area, and timing of proposed burn; and measures to prevent destruction of vegetation providing shade and other ecological functions important to fish habitat.

   iv. Low-severity burns will be used except where the objective is to restore deciduous trees, as describe below under part “v.”, with a goal of creating a mosaic pattern of burned and unburned landscape. Low severity burns, as defined in the National Fire Plan (2002), are characterized by the following: low soil heating or light ground char occurs where litter is scorched, charred, or consumed, but the duff is left largely intact. Woody debris accumulation is partially consumed or charred. Mineral soil is not changed. Minimal numbers of trees, typically pole/saplings, will be killed.

   v. Moderate-severity burns are permitted only where needed to invigorate decadent aspen stands, willows, and other native deciduous species and may be targeted in no more than 20% of the area within RHCAs or Riparian Reserves /6th field HUC/year. Such burns shall be contained within the observable historical boundaries of the aspen stand, willow site, other deciduous species, and associated meadows; additional area outside of the “historical boundaries” may be added to create controllable burn boundaries. Moderate- severity, as defined in the National Fire Plan (2002), is characterized by the following: moderate soil heating or moderate ground char occurs where the litter on forest sites is consumed and the duff is deeply charred or consumed, but the underlying mineral soil surface is not visibly altered. Light colored ash is present. Woody debris is mostly consumed, except for logs, which are deeply charred.

   vi. Fire lines will be limited to five feet in width, constructed with erosion control structures, such as water bars, and restored to pre-project conditions before the winter following the controlled fire. To the extent possible, do not remove vegetation providing stream shade or other ecological functions that are important to streams.

   vii. Ignition can occur anywhere within the RR and RHCAs area as long as project design criteria are met.

   viii. Avoid water withdrawals from fish bearing streams whenever possible. Water drafting must take no more than 10% of the stream flow and must not dewater the channel to the point of isolating fish. Pump intakes shall have fish screens consistent with NMFS fish screening criteria (NMFS 2011).

b. **Non-commercial thinning associated with Moderate-severity burns**
   i. Non-commercial tree thinning and slash removal is allowed only as required to adjust fuel loads to implement a moderate-severity burn to promote growth of deciduous trees and shrubs, such as aspen, cottonwood, willow, other deciduous species, and associated meadows.
   ii. Thinning is allowed only in dry forest types (i.e., east of the crest of the Cascade mountains and southwestern Oregon). Further, this can be applied to more localized fire-dependent ecosystems, such as oak woodlands, west of the Cascade mountain crest
   iii. To project legacy trees, thinning from below is allowed. If conifers are even-aged pole, sapling, or mid-seral with no legacy trees, thin existing trees to the degree necessary to promote a moderate-severity burn.
   iv. No slash burning is allowed within 30' of any stream. To the extent possible, avoid creating hydrophobic soils when burning slash. Slash piles should be far enough away from the stream channel so any sediment resulting from this action will be unlikely to reach any stream.
   v. Apply PDC in National Fire Plan salmonid criteria (2005) for limits on mortality to residual overstory vegetation.
   vi. Only hand equipment—chain saws, axes, Pulaski's, etc.—may be used for felling.
   vii. Where livestock and/or wildlife grazing could be a threat to restoration of aspen, cottonwood, willow, alder, and other deciduous vegetation and an immediate moderate-severity burn would consume large amounts of felled trees, consider delaying the burn and leaving felled trees in place to create grazing barriers to help assure plant growth.
   viii. All projects in this category shall be accompanied by livestock grazing practices that promote the attainment of moderate-severity burn objectives.

16. **Riparian Vegetation Planting** includes the planting of native riparian species that would occur under natural disturbance regimes. Activities may include the following: planting conifers, deciduous trees and shrubs; placement of sedge and or rush mats; gathering and planting willow cuttings. The resulting benefits to the aquatic system can include desired levels of stream shade, bank stability, stream nutrients, large wood inputs, increased grasses, forbs, and shrubs, and reduced soil erosion. Equipment may include excavators, backhoes, dump trucks, power augers, chainsaws, and manual tools.
    a. Experienced silviculturists, botanists, ecologists, or associated technicians shall be involved in designing vegetation treatments.
    b. Species to be planted will be of the same species that naturally occur in the project area. Acquire native seed and/or plant sources as close to the watershed as possible.
    c. Tree and shrub species, willow cuttings, as well as sedge and rush mats to be used as transplant material shall come from outside the bankfull width,

typically in terraces (abandoned flood plains), or where such plants are abundant.

d. Sedge and rush mats should be sized to prevent their movement during high flow events.
e. Concentrate plantings above the bankfull elevation.
f. Removal of native and non-native vegetation that will compete with plantings is permitted.
g. Exclosure fencing to prevent utilization of plantings by deer, elk, and livestock is permitted.

17. **Bull Trout Protection** includes the removal of brook trout or other non-native fish species via electrofishing or other manual means to protect Bull trout from competition and/or hybridization.
    a. For brook trout or other non-native fish species removal, staff experienced in the specific removal method shall be involved in project design and implementation.
    b. When using electrofishing for removal of brook trout and/or other non-native fish species, use the following guidelines:
        i. Electrofishing shall be conducted using the methods outlined in the National Marine Fisheries Service's guidelines. (NMFS 2000 - http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf). Those guidelines are available from the NMFS Northwest Region, Protected Resources Division in Portland, Oregon.
        ii. Electrofishing equipment shall be operated at the lowest possible effective settings to minimize injury or mortality to bull trout.
        iii. To reduce adverse effects to bull trout, electrofishing shall only occur from May 1 (or after emergence occurs) to July 31 in known bull trout spawning areas. No electrofishing will occur in any bull trout habitat after August 15.
        iv. Electrofishing shall not be conducted when the water conditions are turbid and visibility is poor. This condition may be experienced when the sampler cannot see the stream bottom in 1 foot of water.
        v. Electrofishing will not be conducted within core areas that contain 100 or fewer adult bull trout.
    c. Other removal methods, such as dip netting, spearing, and other means can be used.

18. **Beaver Habitat Restoration** includes installation of in-channel structures to encourage beavers to build dams in incised channels and across potential floodplain surfaces. The dams are expected to entrain substrate, aggrade the bottom, and reconnect the stream to the floodplain.
    a. **In-channel structures**
        i. Consist of porous channel-spanning structures comprised of biodegradable vertical posts (beaver dam support [BDS] structures) approximately 0.5 to 1 meter apart and at a height intended to act as the crest elevation of an active beaver dam. Variation of this restoration

treatment may include post lines only, post lines with wicker weaves, construction of starter dams, reinforcement of existing active beaver dams, and reinforcement of abandoned beaver dams (Pollock 2012).

ii. Place BDS structures in areas conducive to dam construction as determined by stream gradient and/or historical beaver use.

iii. Place in areas with sufficient deciduous shrub and trees to promote sustained beaver occupancy.

b. **Habitat Restoration**

i. Drainages historically occupied by beaver, but which may be currently unsuitable for relocations, may require management for improvement and recovery. Restoration activities may include planting riparian hardwoods (species such as willow, red osier dogwood, and alder) and building exclosures (such as temporary fences) to protect and enhance existing or planted riparian hardwoods until they are established (Malheur National Forest and the Keystone Project 2007).[1]

ii. Maintain or develop grazing plans that will ensure the success of beaver habitat restoration objectives.

iii. As a means to restore desired vegetation (e.g., aspen, willow, alder, cottonwood) associated with quality beaver habitat, follow project design criteria in the *Riparian Vegetation Treatment (controlled burning) b. Non-commercial thinning associated with Moderate-severity burns* category.

19. Sudden Oak Death Treatments – (This section was authored by BLM, FS, and NMFS Level I Team staff in SW Oregon.**)** Treatments, within 1 site potential tree height of streams, would be used to eradicate *Phytophthora ramorum*, an invasive pathogen of unknown origin, to maintain and protect riparian and adjacent upland vegetation. Oregon state regulations require eradication of the pathogen on sites considered to be of highest risk for advancing further spread of *P. ramorum* into previously un-infected areas. Eradication activities include: 1) Manual and mechanical treatment (cutting of infected host species to create a buffer area; common examples are tanoak, rhododendron, and evergreen huckleberry); 2) Herbicide (aquatic glyphosate or aquatic imazapyr) treatment of tanoak to prevent resprouting; 3) Fuel treatment (burning the cut vegetation), 4) Temporary site access (for heavy equipment or foot traffic), and 5) Site restoration/planting. The proposed action does not include commercial extraction or the cutting of non-host trees or plants.

a. General – Treatments will occur within 1 site potential tree height of streams. The zone of eradication includes all host plants (i.e., infected AND uninfected host plants, such as tanoaks, Pacific rhododendron [*Rhododendron macrophyllum*], and evergreen huckleberry [*Vaccinium ovatum*]) in a buffer zone that extends out up to 300 feet from the infected plant(s). Also proposed for treatment would be understory conifer trees (sapling sized, generally less than or equal to 6 inches) but *only* if they are infected.

[1] Malheur National Forest and the Keystone Project. 2007. Beaver Management Strategy.

i. Host plant species are determined based on host species affected at the site or information from recent research. Updated host lists are posted at http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/index.shtml
ii. Multiple infestations within close proximity to each other would be buffered by up to 300 feet to create a single treatment site.
iii. The proposed action does not include commercial extraction or the cutting of non-host trees or plants.

b. Manual & Mechanical Treatment (Cutting and Piling) – Manual and/or mechanical treatment (cutting) would occur on all sites. Host species as described above, would be cut and/or piled as stated below:

i. General
   (a) Retain/protect non-host conifer LWD and conifer and non-tanoak reserve trees.
   (b) Cut only host vegetation adjacent to an ESA-critical habitat unless fire behavior or fire effects warrant it. Maintain as much understory shade as practical.
   (c) Non-host brush or hardwood tree species may also be cut if resource specialists determine they pose the risk of fire spread.
   (d) Non-host conifers *less than* eight inches DBH would be cut only when needed to allow for safe burning of the site.
   (e) Non-host conifers *greater than* eight inches DBH, but less than or equal to 16 inches, would generally be reserved from cutting except when needed to facilitate falling of tanoak or to reduce ladder fuels.
   (f) Host leaf litter and other fine plant material in the eradication zones would also be raked into the piles.
   (g) Piles would be located a minimum of 15 feet from conifer logs, stumps, snags, or conifer trees greater than 16 inch diameter-at- DBH whenever possible.
   (h) Every effort would be made to prevent piling within 25 feet of fish-bearing streams when topography allows. Piled material could be placed in the channel only when slopes are greater than 60%.

ii. Manual (chain saw) – Removal of the above-ground portion of the infected vegetation by cutting with chainsaws.
   (a) Hand-piling of uninfected buffer zone cut vegetation less than or equal to eight inches DBH and all foliage would occur in the eradication zone.
   (b) Transport no more than a one day supply of fuel for chainsaws into riparian areas.
   (c) Fueling and refueling of chainsaws would not occur within 100 feet of surface waters to prevent direct delivery of contaminants into a water body.

iii. Mechanical Treatment (Excavator and Feller/Buncher) – Excavators and feller/bunchers would only be used in sites that are primarily tanoak and where site conditions are feasible.
   (a) Minimize ground disturbance by operating equipment on cut slash and piling it upon egress.

(b) Only operate heavy mechanized equipment on slopes less than 35% and when soil moisture is not greater than 25%.
(c) Refuel equipment at least 150 feet from water bodies or use absorbent pads for immobile equipment (or as far as possible from the water body where local site conditions do not allow a 150 foot setback) to prevent direct delivery of contaminants into associated water bodies.
(d) See **Temporary Site Access (Heavy Equipment and Trail Construction)** below for additional heavy equipment project design criteria.

c. **Herbicide Treatment (Stem Injection, Cut-stump/Hack & Squirt, Wicking/Wiping, and Spot Spray)**

i. **Herbicides –** The only herbicides proposed for use are aquatic-labeled glyphosate and aquatic-labeled imazapyr in accordance with project design criteria for herbicides in aquatic restoration category 13. Non-native Invasive Plant Control, (e) Chemical Methods.
ii. **Herbicide Application Methods –** Only stem injection, cut-stump/hack & squirt, wicking/wiping, and spot spraying with hand-held nozzles will be used for SOD treatments. Treat only the minimum area necessary for effective control.
iii. No broadcast spraying of herbicides.
iv. Only daily quantities of aquatic-labeled glyphosate or aquatic-labeled imazapyr will be transported to the project site.
v. Herbicides will be applied in accordance with state and federal law. An Oregon Licensed applicator with forestry, aquatic, and/or right-of-way categories would be utilized. All herbicide mixing would be done in the presence of an agency Project Inspector.
vi. Equipment cleaning and storage and disposal containers would follow all applicable state and Federal laws.
vii. The licensed herbicide applicator would prepare a written herbicide Spill Contingency Plan in advance of the actual aquatic-labeled glyphosate or imazapyr application, then submit it to the Authorized Officer prior to operations, and keep a copy with each crew. The plan would include reporting procedures, including reporting spills to the appropriate regulatory agency. The plan would also address transportation routes so that hazardous conditions are avoided to the extent possible. An agency approved Spill Containment Kit would be on-site during all stages of applications.

d. **Fuel Treatment (Broadcast and/or Pile Burning of Cut Vegetation)**

i. **General**

(a) An experienced fuels technician, silviculturists and fisheries biologist shall be involved in designing prescribed burn treatments.
(b) Prescriptions and burn plans will be prepared to implement safe and effective treatments.
(c) To minimize soil erosion, loss of soil productivity, and water quality degradation, an interdisciplinary team will review the infestation site prior to treatment and will evaluate the need for mitigation measures.

Recommended rehabilitation work will be completed by the action agency prior to the fall run-off period.

(d) Consume infested material to reduce or eliminate the pathogen on the site.

(e) To the extent practical, retain all non-infected conifers, non-host hardwoods, and conifer large downed wood within and outside of fire line by wetting, directional falling, or limbing of live trees. Construct fireline around logs when practical.

(f) Avoid creating hydrophobic soils.

(g) Any placement of portable pumps adjacent to streams for pre-treating of fuels or mop-up will have the required containment kit and absorbent pads for the pump and fuel can.

(h) Avoid water withdrawals from fish bearing streams whenever possible. Water drafting must take no more than 10% of the stream flow and must not dewater the channel to the point of isolating fish. Pump intakes shall have fish screens consistent with *NOAA Fisheries Anadromous Salmonid Passage Facility Design* (2011), located at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf

ii. **Pile Burning** – Burning of hand piles would be the primary method of burning since there is a need to burn the infected sites in a short period of time and piles can be burned almost year round. Burning of hand piles normally occurs during November, December, and January, but could occur any time of the year.

(a) Piles would be located a minimum of 15 feet from conifer logs, stumps, snags, or Douglas-fir trees greater than 16 inch DBH whenever possible.

(b) Every effort would be made to prevent piling and burning within 25 feet of fish-bearing streams when topography allows. Slopes greater than 60% could have the potential for piled material in the channel.

iii. **Broadcast Burning** – Broadcast burning is highly dependent on variables including: location, slope, aspect, unit size and shape, neighboring ownership, defensible burning boundaries, road access, weather, fire danger levels, and length of drying period for vegetation to cure.

(a) Fire- lines would be dug or scraped where needed to prevent fire spread on the perimeter of treatment sites. Fire-line construction would clear an eight foot wide path of vegetation less than four inches in diameter and trees would be limbed eight feet from the ground. Up to three feet of the fire-line would be cleared to mineral soil. A three-foot section would be removed when needed from down logs where the log crosses the fire-trail. All snags and logs would remain on site. Fire-lines would be constructed with erosion control structures and restored to pre-project conditions before the winter following the controlled fire. To the greatest degree possible, vegetation providing stream shade or other ecological functions important to streams would not be removed.

(b) Broadcast burning would occur during the fall after the first heavy rains, in the winter, or in the spring prior to fire season. Most burning would likely occur in spring or under spring-like conditions. Spring-like conditions can generally be described by the following conditions 1) saturated soils; 2) fuel moistures of 32% or greater in larger fuels (1000 hour/9" diameter or greater fuels); 3) live fuel moistures of 250% or greater; 4) air temperatures less than 70°F; 5) relative humidity of 30% or greater; and 6) burning occurring within a dry period lasting typically no more than five days.

e. Temporary Site Access (Heavy Equipment and Foot Traffic) –Temporary heavy mechanized equipment access is proposed where one-time entry is needed for access to eradication sites. Temporary site access would only be used to move equipment off an existing road and "walk" the equipment to the site. Previously existing spur roads or skid roads and stable areas could be used for heavy equipment access. The need for temporary access would be highly variable, depending on availability and treatment being considered for the entry. Access trails could be constructed into sites without road access.

i. **General**

(a) No roads would be constructed or reconstructed for SOD treatments in riparian areas.
(b) Blading or rocking would not occur.
(c) No cutting of conifers greater than 16 inches DBH within the stream influence zone for access.
(d) See **Mechanical Treatment (Excavator and Feller/Buncher)** above for additional project design criteria.

ii. **Temporary Heavy Equipment Site Access**

(a) Temporary heavy equipment access is defined as a minimal travelway for the purpose of site access that is used over the course of the eradication activities.
(b) Temporary heavy equipment access locations and stabilization measures are typically determined by the Contract Officer Representative, who would request the advice of a watershed specialist in determining the most appropriate location and stabilization measures to be required.
(c) All temporary travelways used to walk in heavy mechanized equipment will be designated by a soil scientist or hydrologist and approved as the course that will produce the least potential damage to water quality.
(d) Site access off of existing roads for heavy equipment would be minimal and for the purpose of limited machine access only.
(e) Stream channel crossing will be located as to minimize adverse effects to water quality, streambank stability, and riparian vegetation.
(f) Minimize or avoid locating within stream influence zones (1 site potential tree height for fish bearing or perennial stream or critical habitat).
(g) Do not locate on side slopes > 35 %.
(h) Do not access areas determined to have high erosion potential.

(i) Do not construct or use outside of dry conditions.
(j) Restore as directed by physical scientist (e.g., seed and/or plant access site, water bar, use erosion control techniques, prevent vehicle access after access).

iii. **Temporary Foot Traffic Access –** Temporary access trails within riparian areas could be constructed into sites without road access.
(a) Access trail construction would entail minimal brushing necessary for safe access. Temporary trails may be up to four feet wide and all vegetation less than five inches would be cut by chainsaws or hand tools. Trees along the trail would be limbed up to eight feet on the side adjacent to the trail to allow for movement of equipment and personnel. No clearing of duff or organic layer would occur on the ground surface.
(b) Up to twenty miles per year of temporary non-motorized access trails within riparian areas would be constructed. Repeat treatments to prevent re-sprouting of tanoak could require repeat access; temporary access trails would be rehabilitated after each season of use.

f. Site Restoration -- Vegetation planting would occur as a means to help restore plant species composition and structure that would occur under natural disturbance regimes. Site restoration equipment may include manual tools, such as shovels and hoedads.
i. Minimize ground disturbance by clearing only area necessary for effective planting.
ii. Exposed soils that may deliver sediment to streams will be treated with grass seed (preferably native grass seed if available), slash, water bars or other appropriate methods that will minimize or eliminate sediment delivery.
iii. Planting will occur with Douglas-fir or other non-host species on sites when area is determined to be disease free.
iv. Species to be planted must be the same species that naturally occur in the project area.

g. LIMITATIONS to SOD Treatments – SOD eradication activities with a “May Effect” that *exceed* the below Limitations #1, #2 and #3 criteria in occupied coho salmon streams, designated critical habitat streams, and in unoccupied perennial streams that flow into coho salmon streams or coho critical habitat are not covered under this consultation.
i. **Limitation #1: Contiguous Stream Length**. The SOD eradication activities proposed for implementation within one site potential tree height shall not exceed the following shade removal criteria (Table 7).

Table 7 – Limitation #1: Contiguous stream length and activity intensity criteria based on stream size.
Small perennial streams (defined as less than 27 feet ordinary high water elevation (OHW) width)
A maximum of **30% removal of canopy cover, which provides stream shade, may occur** over a contiguous maximum of **0.5 stream length mile*…** ***OR***
A maximum of **50% removal of canopy cover, which provides stream shade, may occur over a** contiguous maximum of **0.25 stream length mile*.**
Medium-to-Large perennial streams (defined as equal to or greater than 27 feet OHW width)
A maximum of **50% removal of canopy cover, which provides stream shade, may occur over a** contiguous maximum of **0.5 stream length mile*.**
***Treatment Limitations to Contiguous Stream Length:** All contiguous treated riparian segments within 1 SPT will be separated by a distance of **4,600 feet**, where no eradication activities have been or will be applied. This 4,600-foot separation of non-treatment will occur between sequential contiguous treatments.

ii. **Limitations #2 and #3.**

(a) Limitation #2. Must stay at or below *3 miles of Treatment for any 5-year Period.* Treatments include any "May Effect" activity within one SPTH.

(b) Limitation #3. Must stay at or below *3% of the Total Federal Perennial Stream miles per Watershed*.

(c) Tracking and Check Points. To stay within the limitations #2 and #3, the action agencies will implement the following parameters.

(i) **When eradication activities exceed 85% of either Limitation #2 *or* Limitation #3 for any 5-year period:** The action agencies will notify NMFS informing them of the approaching exceedance (via the ARBO II e-mail box). This notification will trigger a local Level I team meeting.

(A) The action agencies will present information on cumulative SOD activities including that listed under **Annual Requirements (see below, section j)**.

(B) The action agencies will present their best estimate of additional stream miles needing SOD eradication activities within the 5-year period, along with treatment information. The Level I team will develop a strategy and procedure for dealing with the exceedance when the action agency's best estimate of additional treatment reaches the 95% threshold.

(C) The primary goal will be to determine how to provide coverage for implementation of the additional needed SOD eradication activities without delay and without exceeding the amount and extent of effects authorized by the biological opinion.

h. **Annual Requirements**

i. **Pre Project Notification**

(a) Follow ARRB II Project Notification criteria (see **Section II A Project Administration)**. In the *project description column* include the following items:

(i) Stream size (see Table 8)

(ii) Acres treated within 1 SPTH of perennial streams

(iii) Treatment on one or both sides of stream

(iv) Proximity of treatment to edge of stream (bankfull width)

(v) Proximity of coho/CH/EFH to the treatment unit

ii. **Post Project Completion**

(a) Follow ARBA II Project Completion Report criteria (see **Section II A Project Administration)**.

(b) Action agencies will also provide annual monitoring data to the Level 1 Team for post project activities covering the following four items. Note: Items (i) and (ii) below could be reported by individual action agencies. Items (iii) and (iv) below will be reported jointly.

(i) **Site/Year Map:** Provide an annual map of all cumulative locations of SOD eradication activities. The map will depict treatment sites by year and 5th field watershed.

(ii) **Monitoring Spreadsheet**: Report treatment unit data following the Table 10 spreadsheet format.

(iii) **Treatment Tracking – Limitation #1**: Report total annual miles of treatment as they apply to Table 9.

(iv) **Treatment Tracking - Limitation #2**: Report the total annual miles of treatment (for all action agencies combined) per year. Also describe in relation to exceeding 3 miles of treatment for a 5 year period (i.e., combined cumulative treatments are x% of the 3 miles).

(v) **Treatment Tracking – Limitation #3**: Report the total annual miles of treatment by 5th field watershed (for all action agencies combined) per year. Also describe in relation to exceeding 3% of the total perennial stream miles in any given 5th field watershed for a 5 year period (i.e., combined cumulative treatments are x% of each watershed).

Table 8. SOD Treatment Post-Notification Reporting

Units w/in 1 SPTH of Perennial Stream											
Unit number and stream size (small or medium-to-large)	**5th field HUC**	**Date Pre-reported**	**Acres Pre-reported**	**Date Cut and if applicable Piled**	**Date Burned**	**Acres treated**	**Linear distance of treatment along stream (feet or miles)**	**Treatment on one or both side of stream**	**Proximity of treatment to edge of stream (bankfull width) (feet)**	**Proximity of coho/CH/ EFH to the unit (feet or miles)**	**Percent removal of shade-providing-canopy cover**

20. **Fisheries, Hydrology, Geomorphology, Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration** include assessments and monitoring projects that could or are associated with planning, implementation, and monitoring of aquatic restoration projects covered by this ARBA II. Such support projects may include surveys to document the following aquatic and riparian attributes: fish habitat, hydrology, channel geomorphology, water quality, fish spawning, fish presence, macro invertebrates, riparian vegetation, wildlife, and cultural resources (including excavating test pits <1 m^2 in size). This also includes effectiveness monitoring associated with projects implemented under ARBO I and ARBO II. Further, this includes presence/absence surveys for listed terrestrial wildlife, bird, and plant species in the project area.
    a. Train personnel in survey methods to prevent or minimize disturbance of fish. Contract specifications should include these methods where appropriate.
    b. Avoid impacts to fish redds. When possible, avoid sampling during spawning periods.
    c. Coordinate with other local agencies to prevent redundant surveys.
    d. Locate excavated material from cultural resource test pits away from stream channels. Replace all material in test pits when survey is completed and stabilize the surface.
    e. Does not include surveys covered with Section 10 (a) 1a of the ESA.

F. NMFS Hydro Fish Passage Review and Approve

These reviews are best initiated during project planning, when project team members are developing goals and objectives. When requested, NMFS will provide an estimate of the time necessary to complete the review based on the complexity of the proposed action and work load considerations at the time of the request. Approval may be delayed if a substandard design is submitted and significant revision is necessary. Project types that require a review include the following:

1. Dewatering construction sites by pumping at a rate that exceeds 3 cfs will require fish screen review
2. Fish passage culverts and bridges that do not meet width standards
3. Headcut Stabilization and channel spanning non-porous weirs that create discrete longitudinal drops > 6”
4. Fish Ladders
5. Irrigation Diversion Replacement/Relocation & Screen Installation/Replacement
6. Dam removal
7. Channel Reconstruction/Relocation projects
8. Side channel reconstruction when the proposed side channel will contain >20% of the bankfull flow.

Refer to *Table 9 –ARBA II Aquatic Restoration Categories: Design Review and Reporting Metrics.*

G. Restoration Review Team (RRT)

The RRT will be comprised of highly skilled interagency (BLM, FS, BIA, NMFS, FWS) fisheries biologists, hydrologists, geomorphologists, soil scientists, and/or engineers to review and help select project designs. The RRT composition will be composed of a four member core group—one individual from each of the following agencies: FS, BLM, NMFS, and FWS. The designated FS and BLM ARBO II contacts will serve as core group members. Additional technical experts from these agencies will be recruited depending on the project to be reviewed.

The reviews will help ensure that projects 1) meet the obligations set forth in the ARBA II and subsequent ARBO II; 2) are consistent with similar projects; 3) maximize ecological benefits of restoration and recovery projects; and 4) ensure consistent use and implementation throughout the geographic area covered by the ARBA II. The RRT review will be completed within 30 days of the request, otherwise the project is deemed appropriate and no further review is required. Any RRT concerns must be described in detail, referencing underlying scientific (based on peer-reviewed science) or policy rationale, and include recommended changes to the proposed project to address the specific concerns. Project types that require RRT review include the following:

1. ARBA II Project Inclusion by Amendment (Chapter I, part E)
2. Dam removal
3. Channel Reconstruction/Relocation projects
4. Precedent and/or policy setting actions, such as the application of new technology

Another purpose of the RRT is to provide updates and clarifications of the ARBA II and subsequent ARBO II to all users to ensure consistent use and to resolve inconsistencies and obtain clarification when needed. An ARBO II Addendum will track all clarifications, changes, and interpretations, which will serve as the administrative record of the RRT. The RRT does not replace any existing review process, nor shall it slow down project implementation unless significant technical, policy, and/or program concerns with a particular restoration approach are identified.

Table 9 –ARBA II Aquatic Restoration Categories: Design Review and Reporting Metrics		
Activity Category	**Design Review**	**Reporting Metrics**
1. Fish Passage Restoration (Stream Simulations Culvert and Bridge Projects; Headcut and Grade Stabilization; Fish Ladders; Irrigation Diversion Replacement/Relocation & Screen Installation/Replacement.)	**NMFS Hydro Fish Passage Review and Approve for the following:** a) Culverts that do not meet ARBA II width criteria; b) Fish Ladders; c) and Irrigation Diversion Replacement/Relocation & Screen Installation/Replacement; d) Headcut stabilization and channel spanning non Porous Boulder Weirs that create vertical drops > 6”.	Miles of stream restored to fish access
2. Large Wood, Boulder, and Gravel Placement (LW and Boulder Projects; Engineered Log Jams; Porous Boulder Weirs; Gravel Augmentation; Tree Removal for LW Projects	**NMFS Hydro Fish Passage Review and Approve** for Engineered Log jams (non-porous) that span >25% of bankfull channel.	Miles of stream treated
3. Dam, Tidegate, and Legacy Structure Removal	**NMFS Hydro Fish Passage Review and Approve and Restoration Review Team for** removal of dams. **NMFS Hydro Fish Passage Review and Approve** for tidegate removal projects that constrain tidal exchange	Miles of stream restored to fish access and/or treated
4. Channel Reconstruction/Relocation	**NMFS Hydro Fish Passage Review and Approve and Restoration Review Team** for all projects under this category.	Miles of stream reconstructed/ relocated
5. Off- and Side-Channel Habitat Restoration	**NMFS Hydro Fish Passage Review and Approve** when the proposed side channel will contain >20% of the bankfull flow.	Miles of off- and side-channel habitat restored or created
6. Streambank Restoration	NA	Miles of streambank treated
7. Set-back or Removal of Existing Berms, Dikes, and Levees	NA	Miles and acres of floodplain treated
8. Reduction/Relocation of Recreation Impacts	NA	Miles and acres of floodplain treated
9. Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering	NA	Miles of stream and acres treated
10. Piling and other Structure Removal	NA	Miles of stream/shoreline treated

Table 9 (continued) –ARBA II Aquatic Restoration Categories: Design Review and Reporting Metrics		
Activity Category	**Design Review**	**Reporting Metrics**
11. In-channel Nutrient Enhancement	NA	Miles of stream treated
12. Road and Trail Erosion Control and Decommissioning	NA	Miles of road treated
13. Non-Native invasive Plant Control	NA	Acres treated
14. Juniper Removal	NA	Acres treated
15. Riparian Vegetation Treatment (controlled burning)	NA	Acres treated
16. Riparian Vegetation Planting	NA	Acres treated
17. Bull Tout Protection	**Restoration Review Team** for all projects under this category.	Miles of stream improved
18. Beaver Habitat Restoration	NA	Miles of stream improved
19. Sudden Oak Death Treatments	NA	Acres treated
20. Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration	NA	Miles surveyed

H. Project Design Criteria for Wildlife, Plant, and Invertebrate Species and Habitats

This section provides Project Design Criteria (PDC) and Conservation Measures (CMs) that ensure restoration activities minimize or avoid potential adverse effects to listed terrestrial species and critical habitat. The programmatic activities are designed to "Not Likely to Adversely Affect" (NLAA) all terrestrial species, except as discussed below (II. C.1. Birds) for a limited number of actions that are "Likely to Adversely Affect" for Northern spotted owls (NSO) and marbled murrelets (MAMU),

1. The following CMs apply to all ESA-listed terrestrial species for all programmatic activities:
   a. Aquatic restoration actions will not remove or downgrade suitable habitat (on either public or private land) for any listed terrestrial species.
   b. Effects of danger tree removal will be either discountable or insignificant to ESA-listed terrestrial species and their critical habitat.

c. All restoration activities must have the unit's botanist and terrestrial wildlife biologist input/analysis of the project design and their site-specific species assessment to proceed. This includes a plant survey and nest analysis (or survey, as described in section II.H. 2. Birds, if suitable habitat is known to occur within the project prior to project implementation.
d. There will be no disturbance allowed from blasting activities as they are not part of the proposed action.
e. The unit wildlife biologist is responsible for ensuring that the correct effects determination is made for each project. The unit wildlife biologist may increase or decrease disturbance distances according to the best available scientific information and site-specific conditions. Refer to Tables 10-12. For instance, if a known NSO site is surveyed to protocol and the owls are determined to be non-nesting, the unit biologist may determine that no disturbance or disruption would occur and lift the associated restrictions on activities within disruption distances during the year of survey.

Table 10 – Disturbance Distances and Time Periods When Disturbance (and Possibly Disruption) May Occur for Terrestrial Species.*

Species	Disturbance Distance (in miles)	Time Period Applicable
Northern spotted owl (nesting)	See table 11	Mar 1 – September 30
Marbled murrelet (nesting)	See table 12	Apr 1 – Sept 15 w/ 2-hr timing
Canada lynx (denning)	0.25	May 1 – Aug 31
Gray wolf (active dens/rendezvous sites)	1.0	Jan 1 – Dec 31
Grizzly bear (denning)	0.25	Oct 15 – May 15
Grizzly bear (early foraging habitat)	0.25	Mar 15 – July 15
Grizzly bear (late foraging habitat)	0.25 (actions >1 day)	July 16 – Nov 15
Woodland caribou	Recovery Area	Early winter
All Plants	0.25**	Jan 1 – Dec 31

*See CMs below for additional details. **If project is within 0.25 mile of a listed plant, then measures must be taken to minimize threats to NE or NLAA the species to be covered by this programmatic consultation.

2. **Birds –** This ARBA II attempts to minimize or avoid adverse effects to listed birds by implementing aquatic restoration actions outside of critical nesting period windows and/or outside of disturbance or disruption distances from occupied habitat. However, some aquatic restoration activities must occur within a listed bird critical nesting period or within a disturbance or disruption distance. A limited number of aquatic restoration activities that adversely affect listed birds will therefore occur under this proposed action.
   a. Conditions common to all programmatic activities that will be applied to avoid disturbance or disruption of listed bird species include:

i. The proposed activities included in this document are consistent with the Northwest Forest Plan (USDA and USDI 1994) and FS Land and Resource Management Plans and BLM Resource Management Plans as amended by the Record of Decision for Amendments to the Survey and Manage, Protection Buffer, and Other Mitigation Measures Standards and Guidelines, USDA Forest Service and USDI BLM (USDA and USDI 2001, USDI 2008 as amended by the 2011 agreement).
ii. The proposed activities do not include those that would result in loss of suitable habitat (on either public or private land) for the identified ESA-listed species.
iii. The proposed activities must have wildlife biologist input/analysis to proceed.
iv. As a general rule, a disruption site is defined as approximately 100 meters radius around the project site. However, the unit wildlife biologist has the discretion to adjust disturbance distances, based on site-specific conditions.
v. No hovering or lifting within 500 feet of the ground within occupied spotted owl habitat during the critical breeding season by ICS Type I or II helicopters would occur as part of any proposed action addressed by this assessment.

b. **Northern spotted owl**

i. **NSO1**: To reduce adverse effects to NSO, projects will not generally occur between March1 – July 15 (July 7 for the Oregon North Coast Planning Province [ONCPP]) if there is an active known owl site, predicted owl site (as determined through an approved modeling process, such as ITS), RPO (Reference Point Owl) and/or occupied habitat within the disruption distance of the project area. Projects should (a) be delayed until after the critical breeding season (unless action involves Type I helicopters, which extend critical nesting window to September 30); (b) delayed until it is determined that young are not present.
ii. **NSO2**: The unit wildlife biologist may extend the restricted season based on site-specific information (such as a late or recycle nesting attempt).
iii. **NSO3**: No suitable habitat will be removed or downgraded. No adverse effects will occur to any PCE of critical habitat.
iv. **NSO4**: NSO disruption distances applicable to the equipment types proposed in the ARBA II include and can be locally altered based on current information. Refer to Table 11.
v. **NSO5**: No activity within this ARBA II will cause adverse effects to proposed critical habitat when analyzed against the appropriate local scale as determined by the unit wildlife biologist.

Table 11 – NSO Disturbance Distances and Time Periods

DISTURBANCE SOURCE	DISTURBANCE DISTANCES DURING THE BREEDING PERIOD[1] (MAR 1 – SEP 30)	DISRUPTION DISTANCES DURING THE CRITICAL BREEDING PERIOD[1,4] MAR 1 – JUL 15 (MAR 1 – JUL 7 ONCPP))	DISRUPTION DISTANCES DURING THE LATE BREEDING PERIOD[1] JUL 16-SEP 30 (JUL 8 – SEP 30 ONCPP)
Use of chainsaws	440 yards (0.25 mile)	65 yards	0 yards
Heavy equipment	440 yards (0.25 mile)	35 yards	0 yards
Tree climbing	440 yards (0.25 mile)	35 yards	0 yards
Burning	440 yards (0.25 mile)	440 yards (0.25 mile)	0 yards
Use of Type I helicopter [2]	880 yards (0.5 mile)	440 yards (0.25 mile)	440 yards (0.25 mile)
Use of Type II, III or IV helicopter [3]	440 yards (0.25 mile)	120 yards	0 yards
Use of fixed-wing aircraft	440 yards (0.25 mile)	120 yards	0 yards
Pile driving	440 yards (0.25 mile)	60 yards	0 yards

1 Noise disturbance and disruption distances were developed from a sound threshold (USFWS. 2003a. Appendix 1. Estimates of distances at which incidental take of murrelets and spotted owls due to harassment are anticipated from sound-generating, forest-management activities in Olympic National Forest). Smoke disturbance and disruption distances are based on a USFWS white paper (USFWS. 2008. Observations of Smoke Effects on Northern Spotted Owls. Compiled by J. Thrailkill, Oregon Department of Fish and Wildlife).

2 Type I helicopters seat at least 16 people and have a minimum capacity of 5,000 lbs. Both a CH-47 (Chinook) and UH-60 (Blackhawk) are Type I helicopters. Kmax helicopters are considered "other" for the purposes of disturbance. Sound readings from Kmax helicopter logging on the Olympic NF registered 86 dB at 150 yards (Piper. 2006. Pers. comm. Sound Measurements for Harris Timber Sale, Olympic National Forest).

3 All other helicopters (including Kmax).

4 Dates may vary slightly depending on site specific conditions.

c. **Marbled Murrelet**

i. **MM1:** Projects will not occur within the applicable disruption and disturbance distances for MAMUs within their critical nesting period (Table 12), unless a protocol survey determines MAMUs are not present. Otherwise the project would be LAA and either delayed until August 6 (with 2-hr timing restrictions) or until it is determined that young are not present or counted toward the limited number of LAA projects covered under this programmatic (with 2-hr timing restrictions).

ii. **MM2:** Projects implemented between August 6 and September 15 would not begin until 2 hours after sunrise and would end 2 hours before sunset.

iii. **MM3:** No suitable, potential, or critical MAMU habitat is to be removed or downgraded.

iv. **MM4:** Garbage containing food and food trash generated by workers in project areas is secured or removed to minimize attraction of corvids, which have been identified as predators of murrelet eggs and young.

v. **MM5:** Table 12 shows MAMU disruption distances that are applicable to the ARBA II. Distances and times can be locally revised based on current information.

Table 12 – Marbled Murrelet Disturbance Distances and Time Periods

DISTURBANCE SOURCE	DISTURBANCE DISTANCES DURING THE BREEDING PERIOD[1] (APR 1 – SEP 15)	DISRUPTION DISTANCES DURING THE CRITICAL BREEDING PERIOD[1] (APR 1 – AUG 5) *	DISRUPTION DISTANCES DURING THE LATE BREEDING PERIOD[1] with daily timing restrictions *, unless noted otherwise (AUG 6 – SEP 15)
		Standard 14 requires daily timing restrictions* during the entire breeding period, when adjacent to suitable habitat and potential nesting structure for projects (see standard 14 for exemptions).	
Road repair such as culvert replacement	440 yards (0.25 mile)	100 yards	0 yards
Use of chainsaws	440 yards (0.25 mile)	100 yards	0 yards
Tree climbing	440 yards (0.25 mile)	100 yards	0 yards
Use of heavy equipment	440 yards (0.25 mile)	100 yards	0 yards
Burning	440 yards (0.25 mile)	440 yards (0.25 mile)	0 yards
Use of a Type I helicopter [2]	880 yards (0.5 mile)	440 yards (0.25 mile)	440 yards (0.25 mile)
Use of a Type II, III or IV helicopter [3]	440 yards (0.25 mile)	120 yards	0 yards
Use of fixed-wing aircraft	440 yards (0.25 mile)	120 yards	0 yards
Pile driving	440 yards (0.25 mile)	100 yards	0 yards

* Daily timing restrictions: Activities would not begin until 2 hours after sunrise and ending 2 hours before sunset.

1 Noise disturbance and disruption distances were developed from a sound threshold (USFWS. 2003a. Appendix 1. Estimates of distances at which incidental take of murrelets and spotted owls due to harassment are anticipated from sound-generating, forest-management activities in Olympic National Forest). Smoke disturbance and disruption distances are based on a FWS white paper (USFWS 2008b). Human presence (attracting predators/corvids) disturbance and disruption distances for marbled murrelets are based on a FWS white paper (USFWS. 2003b. Visual Harassment Threshold Justification. Compiled by P. Phifer).

2 Type I helicopters seat at least 16 people and have a minimum capacity of 5,000 lbs. Both a CH-47 (Chinook) and UH-60 (Blackhawk) are Type I helicopters. Kmax helicopters are considered “other” for the purposes of disturbance. Sound readings from Kmax helicopter logging on the Olympic NF registered 86 dB at 150 yards (Piper. 2006. Pers. comm. Sound Measurements for Harris Timber Sale, Olympic National Forest).

3 All other helicopters (including Kmax).

Dates may vary slightly depending on site specific conditions.

3. **Terrestrial Definitions Glossary**
   a. **Disturbance Distance –** A disturbance distance consists of the distance from the project boundary outward that would potentially cause a listed species if one was present to be distracted from its normal activity. The unit wildlife biologist is responsible for ensuring that the correct effects determination is made for each project. The unit wildlife biologist may increase or decrease these disturbance distances according to the best available scientific information and site-specific conditions. If a known spotted owl site is surveyed to protocol and the owls are determined to be non-nesting, the unit biologist may determine that no disturbance or disruption would occur and lift the associated restrictions on activities within disruption distances during the year of survey.
   b. **Disruption Distance –** A disruption distance consists of the distance from the project boundary outward that would potentially cause a NSO or MAMU, if one was present, to be distracted from its normal activity to such an extent to significantly impact its normal behavior and create the likelihood of injury (harass). The disruption distance is a subset of the disturbance distance.
   c. **Habitat Definitions**
      i. **NSO Suitable habitat –** Consists of stands with sufficient structure (large trees, snags, and downed wood) to provide opportunities for owl nesting, roosting, and foraging. Generally, these conditions are associated with conifer-dominated stands, 80 years old or older, multi-storied in structure, have trees greater than or equal to 18 inches mean diameter at breast height (dbh), and a canopy closure generally exceeding 60 percent. Stands are defined at a larger scale (i.e., province) as suitable based just on age or size (i.e., 80 years, >18") alone. The local biologist evaluates all project areas to make a final determination of habitat type based on the structural complexity associated with functioning nesting, roosting, and foraging habitat.
      ii. **NSO Known owl site** – A site that was or is occupied by a pair or resident single (1990 to present) as defined by the survey protocol. The specific site location is determined by the unit biologist based on the best and/or most recent information. A known site may be determined to be inactive only in accordance with the survey protocol (USFWS 2010).
      iii. **NSO Predicted owl site** – An area able to support resident spotted owls (i.e., a potential breeding pair) as determined by the interagency occupancy template (USFWS et al. 2008) or other approved modeling method. This is used for determining potential effects to spotted owls where survey data are insufficient.
      iv. **NSO Nest Patch (or stand) –** A 300 meter radius circle around a point (known or predicted owl site), where a spotted owl would be likely to select a nesting tree
      v. **NSO Dispersal habitat –** For assessing impacts to spotted owl habitat, dispersal habitat will refer to the subset of habitat used by dispersing spotted owls that does not contain suitable habitat. These stands provide protection from avian predators and at least minimal foraging opportunities during dispersal. At a minimum, dispersal habitat is

comprised of conifer and mixed mature conifer-hardwood habitats with a canopy cover greater than or equal to 40 percent and conifer trees greater than or equal to 11 inches average dbh but less than the habitat characteristics described for suitable habitat above. Generally, spotted owls use younger stands to move between blocks of suitable habitat, roost, forage and survive until they can establish a nest territory. Juvenile owls also use dispersal habitat to move from natal areas.

vi. **MAMU Suitable habitat –** Conifer-dominated stands that generally are 80 years old or older and/or have trees greater than or equal to 18 inches mean dbh. Murrelet suitable habitat must include nesting structure. Nesting structure consists of platforms that are ≥ 32.5' (9.9 meters) in height, ≥ 4 in. (10 cm) in diameter, contain nesting substrate (e.g., moss, epiphytes, duff) on that platform, and have an access route through the canopy that a murrelet could use to approach and land on the platform (Burger 2002, Nelson & Wilson 2002:24, 27, 42, 97, 100). Additionally, nesting structure has a tree branch or foliage, either on the tree with nesting structure or on a surrounding tree, that provides protective cover over the platform (Nelson & Wilson 2002:98 & 99). Any nesting structure that does not meet all of these characteristics is unlikely to support nesting murrelets. However, we recognize that not all of these characteristics are visible from the ground in all situations. Therefore, a unit wildlife biologist shall make site-specific determinations on the presence of nesting structure.

vii. **MAMU Nesting Structure –** Nesting structure for an individual tree is defined within the current Level II policy for managing MAMU nesting structure in younger stands. This policy is in the process of being updated. Throughout the life of the proposed project, the current version of the policy will be used.

viii. **MAMU Occupied Habitat** – Consists of suitable habitat or nesting structure within younger stands that have been found to meet the definition of occupied by interagency survey protocol (Evans et al. 2003).

4. Mammals

a. **Canada Lynx**

i. **CL1:** No active lynx dens are located within 270 yards (based on sight distance and attenuation of sound in forested environments) of a project.

ii. **CL2**: The project will meet the standards and guidelines identified in the Lynx Conservation Assessment and Strategy (LCAS) and are within the LCAS thresholds (suitable, unsuitable, and denning habitat).

iii. **CL3:** The project will not result in increased off-road vehicle access to lynx habitat during or following implementation.

b. **Gray Wolf**

i. **GW1**: Meets Recovery Plan direction for den and rendezvous sites (i.e., no projects/activities within 1 mile of den or rendezvous sites scheduled to occur between April 15 and June 30). If an active den, rendezvous site is within 1 mile, the project would fall outside the scope of this ARBA II, and a separate consultation would be required to address potential effects.

c. **Grizzly Bear**

i. **GB1**: Projects generating noise above ambient levels within ¼ mile (1 mile for blasting) of any known grizzly bear den site will not occur from October 15 through May 15.

ii. **GB2**: Projects generating noise above ambient levels and located within ¼ mile (1.0 mile for blasting) of early season grizzly bear foraging areas (e.g., low elevation grass/forb habitat, deciduous forest, riparian forest, shrub fields, montane meadows, avalanche chutes) will not occur from March 15 to July 15 if the activity will last for more than one day.

iii. **GB3**: Projects generating noise above ambient levels and located within ¼ mile (1.0 mile for blasting) of late season grizzly bear foraging areas (e.g., high elevation berry fields, shrub fields, fruit/nut sources, wet forest openings, alpine and sub alpine meadows, montane meadows [moist, cool, upland slopes dominated by coniferous trees]) will not occur from July 16 to November 15 if the activity will last for more than one day.

iv. **GB4**: Projects will not increase trail or road densities within grizzly bear core habitat. No road or trail construction or reconstruction will occur in recovery areas.

v. **GB5:** All attractants, including food and garbage, will be stored in a manner unavailable to wildlife at all times.

d. **Woodland Caribou**

i. **WC1**: Projects that are scheduled during early winter in the caribou recovery area (Michael Borysewicz pers. com. 2003) and generate noise above ambient levels will be evaluated by the local wildlife biologist to determine if there will be disturbance effects to caribou.

ii. **WC2:** Any vegetation management will not affect more than 1.0 acre of native forest per year.

iii. **WC3:** Projects will not result in increased off-road vehicle access to caribou habitat.

5. Plants – For threatened or endangered plant species that may occur in project areas within the scope of this ARBA II, the following criteria will be applied:

a. **All Listed Plant Species**

i. **PL1**: A unit botanist will have the following input in all project designs: (a) the botanist will determine whether there are known listed plants or suitable habitat for listed plants in the project area; (b) If a known site of a listed plant is within 0.25-mile of the project action area, or that suitable or potential habitat may be affected by project activities, then a botanist will conduct a site visit/vegetation survey to determine whether listed plants are within the project area. This visit and survey will be conducted at the appropriate time of year to identify the species and determine whether individual listed plants or potential habitat are present and may be adversely affected by project activities (see Table 13).

ii. **PL2:** If one or more listed plants are present and likely to be adversely affected by the project, then the project is not covered by this ARBA II and consultation with the FWS under Section 7 of the ESA must be initiated. If a project will have no effect or is NLAA listed plants it is covered under this ARBA II. Project design criteria should address both the critical life cycle of listed plant species as well as the effective biotic and abiotic environmental factors sustaining rare plant taxa.

iii. **PL3:** Due to soil disturbance that may occur during aquatic restoration activities and use of heavy equipment that could carry seeds and plant parts into project areas, all appropriate prevention measures will be incorporated into contract or equipment rental agreements to avoid introduction and establishment of invasive plants and noxious weeds into project areas.

Table 13 – Optimal Survey Times for Flowering Periods of Listed Plants in Oregon and Washington

Species	Optimal Survey Time Period*
Applegate's Milk-Vetch	June to early August
Bradshaw's Lomatium	April to mid-May
Cook's Lomatium	Mid-March through May (varies with spring moisture)
Gentner's Fritillary	April to June
Golden Paintbrush	April to September
Howell's Spectacular Thelypody	June through July
Kincaid's Lupine	May through July
Large-flowered Wooly Meadowfoam	Mid-March to May (varies with spring moisture)
MacFarlane's four o'clock	May through June
Malheur Wire-Lettuce	July through August
Marsh Sandwort	May to August
McDonald's Rock-cress	Mid-March through June
Nelson's Checkermallow	Late May to Mid-July
Rough Popcornflower	Mid-June to early July
Showy Stickseed	May to July
Spalding's Catchfly	June to September
Ute Ladies'-Tresses	July to late August
Water Howellia	May through August
Wenatchee Mountains Checker-Mallow	June to Mid-August
Western Lily	May to July
Willamette Daisy	Mid-June to early July

*This is a guideline. The site botanist will survey when the time is appropriate.

6. Insects

a. Fenders Blue Butterfly

i. FBB1: No project included in this assessment will remove or disturb Kincaid's lupine, spur lupine *(Lupinus laxiflorus = L. arbustus)* or sickle-keeled lupine *(L. albicaulis)* within the range of the butterfly.

ii. FBB2: No project included in the assessment will remove habitat including the following nectar sources: wild onion (*Allium amplectans*); cat's ear mariposa lily (*Calachortus tolmiei*); common camas (*Camassia quamash*); Oregon sunshine (*Eriophyllum lanatum*); and rose checkermallow (*Sidalcea virgata)* within the range of the butterfly.

III. Description of the Affected Species

The following species descriptions summarize biological requirements and may include other elements, such as historical numbers and distribution, which offer insights into the life histories of affected ESA-listed fish, wildlife, and plants.

A. Fish Species under the Jurisdiction of the FWS

(Species descriptions were provided by the FWS.)

1. **Bull Trout (*Salvelinus confluentus*)**
   a. **Taxonomy –** The bull trout is a native char found in the coastal and intermountain west of North America. Dolly Varden (*Salvelinus malma)* and bull trout were previously considered a single species and were thought to have coastal and interior forms. However, Cavender (1978) described morphometric, meristic and osteological characteristics of the two forms, and provided evidence of specific distinctions between the two. In 1980, the American Fisheries Society formally recognized bull trout and Dolly Varden as separate species (Robins et al. 1980). Despite an overlap in the geographic range of bull trout and Dolly Varden in the Puget Sound area and along the British Columbia coast, there is little evidence of introgression (Hass and McPhail 1991). The Columbia River Basin is considered the region of origin for the bull trout. From the Columbia, dispersal to other drainage systems was accomplished by marine migration and headwater stream capture. Behnke (1980) postulated dispersion to drainages east of the continental divide may have occurred through the North and South Saskatchewan Rivers (Hudson Bay drainage) and the Yukon River system. Marine dispersal may have occurred from Puget Sound north to the Fraser, Skeena and Taku Rivers of British Columbia.
   b. **Species Description –** Bull trout have unusually large heads and mouths for salmonids. Their body colors can vary tremendously depending on their environment, but are often brownish green with lighter (often ranging from pale yellow to crimson) colored spots running along their dorsa and flanks, with spots being absent on the dorsal fin, and light colored to white under bellies. They have white leading edges on their fins, as do other species of char. Bull trout have been measured as large as 103 centimeters (41 inches) in length, with weights as high as 14.5 kilograms (32 pounds). Bull trout may be migratory, moving throughout large river systems, lakes, and even the ocean in coastal populations, or they may be resident, remaining in the same stream their entire lives (USFWS 2011). Migratory bull trout are typically larger than resident bull trout (USFWS 1998)
   c. **Current legal status, including listing history –** The coterminous United States population of the bull trout (<u>*Salvelinus*</u> <u>*confluentus*</u>) was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho,

Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 4; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 715-720).

Throughout its range, the bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007; Rieman et al. 2007; Porter and Nelitz. 2009, pages 4-8). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (70 FR 63898); the rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on our website (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species' coterminous range, which includes the Jarbidge River, Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units)[2]. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table 14). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering (FMO).

[2] The Service's 5 year review (USFWS 2008, pg. 9) identifies six draft recovery units. Until the bull trout draft recovery plan is finalized, the current five interim recovery units are in affect for purposes of section 7 jeopardy analysis and recovery. The adverse modification analysis does not rely on recovery units.

Table 14 – Stream/shoreline distance and reservoir/lake area designated as bull trout critical habitat by state.

State	Stream/Shoreline Miles	Stream/Shoreline Kilometers	Reservoir /Lake Acres	Reservoir/ Lake Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	-	-
Oregon	2,835.9	4,563.9	30,255.5	12,244.0
*Oregon/Idaho	107.7	173.3	-	-
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	-	-
Washington/Idaho	37.2	59.9	-	-
Washington/Oregon	301.3	484.8	-	-
Total	19,729.0	31,750.8	488,251.7	197,589.2
*Pine Creek Drainage which falls within Oregon				

The 2010 revision increases the amount of designated bull trout critical habitat by approximately 76 percent for miles of stream/shoreline and by approximately 71 percent for acres of lakes and reservoirs compared to the 2005 designation.

The final rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: 1) waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or 3) waters where impacts to national security have been identified (75 FR 63898). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit (CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

The primary constituent elements (PCEs), Conservation Role and Description of Critical Habitat – The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898:63943 [October 18, 2010]). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

Thirty-two CHUs within the geographical area occupied by the species at the time of listing are designated under the revised rule. Twenty-nine of the CHUs contain all of the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River basins contain most of the physical or biological features necessary to support the bull trout's particular use of that habitat, other than those physical biological features associated with Primary Constituent Elements (PCEs) 5 and 6, which relate to breeding habitat.

The primary function of individual CHUs is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

Primary Constituent Elements for Bull Trout - Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Based on our current knowledge of the life history, biology, and ecology of this species and the characteristics of the habitat necessary to sustain its essential life-history functions, we have determined that the PCEs, as described within 70 FR 63898 are essential for the conservation of bull trout. A summary of those PCEs follows.

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

5. Water temperatures ranging from 2 °C to 15 °C (36 °F to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

The revised PCE's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PCE to address the presence of nonnative predatory or competitive fish species. Although this PCE applies to both the freshwater and marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

Note that only PCEs 2, 3, 4, 5, and 8 apply to marine nearshore waters identified as critical habitat. Also, lakes and reservoirs within the CHUs also contain most of the physical or biological features necessary to support bull trout, with the exception of those associated with PCEs 1 and 6. Additionally, all except PCE 6 apply to FMO habitat designated as critical habitat.

Critical habitat includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full- pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high-water (MHHW) line, including the uppermost reach of the saltwater wedge within tidally influenced freshwater heads of estuaries. The MHHW line refers to the average of all the higher high-water heights of the two daily tidal levels. Marine critical habitat extends offshore to the depth of 10 meters (m) (33 ft) relative to the mean low low-water (MLLW) line (zero tidal level or average of all the lower low-water heights of the two daily tidal levels). This area between the MHHW line and minus 10 m MLLW line (the average extent of the photic zone) is considered the habitat most consistently used by bull trout in marine waters based on known use, forage fish availability, and ongoing migration studies and captures geological and ecological processes important to maintaining these habitats. This area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Adjacent shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to “destroy or adversely modify” critical habitat by no longer serving the intended conservation role for the species or retaining those PCEs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PCEs to such an extent that the conservation value of critical habitat is appreciably reduced (75 FR 63898:63943; USFWS 2004, Vol. 1. pp. 140-193, Vol. 2. pp. 69-114). The Service’s evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998, pp. 4-39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (75 FR 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (75 FR 63898:63943).

Current Critical Habitat Condition Rangewide –The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (63 FR 31647, June 10 1998; 64 FR 17112, April 8, 1999).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Effects of Climate Change on Bull Trout Critical Habitat – One objective of the final rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PCEs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes).

d. **Life history –** Reproduction: The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989; Pratt 1985). The largest verified bull trout is a

32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep 1996 in Stewart et al. 2007). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Population structure – Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989; Goetz 1989). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989; Goetz 1989), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978;

McPhail and Baxter 1996). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989; Leathe and Graham 1982; Pratt 1992; Rieman and McIntyre 1996).

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Brenkman and Corbett 2005; Frissell 1993; Goetz et al. 2004). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999; MBTSG 1998; Rieman and McIntyre 1993). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993).

Whitesel et al. (2004) noted that although there are multiple resources that contribute to the subject, Spruell et al. (2003) best summarized genetic information on bull trout population structure. Spruell et al. (2003) analyzed 1,847 bull trout from 65 sampling locations, four located in three coastal drainages (Klamath, Queets, and Skagit Rivers), one in the Saskatchewan River drainage (Belly River), and 60 scattered throughout the Columbia River Basin. They concluded that there is a consistent pattern among genetic studies of bull trout, regardless of whether examining allozymes, mitochondrial DNA, or most recently microsatellite loci. Typically, the genetic pattern shows relatively little genetic variation within populations, but substantial divergence among populations. Microsatellite loci analysis supports the existence of at least three major genetically differentiated groups (or evolutionary lineages) of bull trout (Spruell et al. 2003). They were characterized as:

i. "Coastal", including the Deschutes River and all of the Columbia River drainage downstream, as well as most coastal streams in Washington, Oregon, and British Columbia. A compelling case also exists that the Klamath Basin represents a unique evolutionary lineage within the coastal group.

ii. “Snake River”, which also included the John Day, Umatilla, and Walla Walla rivers. Despite close proximity of the John Day and Deschutes Rivers, a striking level of divergence between bull trout in these two systems was observed.

iii. “Upper Columbia River” which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell et al. (2003) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.

Spruell et al. (2003) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor et al. (1999) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello et al. (2003) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Spruell and the biogeographic analysis of Haas and McPhail (2001). Both Taylor et al. (1999) and Spruell et al. (2003) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

Population Dynamics – Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders et al. 1991). Burkey (1989) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989, 1995).

Metapopulation concepts of conservation biology theory have been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993; Dunham and Rieman 1999; Rieman and Dunham 2000). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994). For inland bull trout, metapopulation theory is likely most applicable at the watershed scale where habitat consists of discrete patches or collections of habitat capable of supporting local populations; local populations are for the most part independent and represent discrete reproductive units; and long-term, low-rate dispersal patterns among component populations influences the persistence of at least some of the local populations (Rieman and Dunham 2000). Ideally, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. However, habitat alteration, primarily through the construction of impoundments, dams, and water diversions has fragmented habitats, eliminated migratory corridors, and in many cases isolated bull trout in the headwaters of tributaries (Rieman and Clayton 1997; Dunham and Rieman 1999; Spruell et al. 1999; Rieman and Dunham 2000).

Human-induced factors as well as natural factors affecting bull trout distribution have likely limited the expression of the metapopulation concept for bull trout to patches of habitat within the overall distribution of the species (Dunham and Rieman 1999). However, despite the theoretical fit, the relatively recent and brief time period during which bull trout investigations have taken place does not provide certainty as to whether a metapopulation dynamic is occurring (e.g., a balance between local extirpations and recolonizations) across the range of the bull trout or whether the persistence of bull trout in large or closely interconnected habitat patches (Dunham and Rieman 1999) is simply reflective of a general deterministic trend towards extinction of the species where the larger or interconnected patches are relics of historically wider distribution (Rieman and Dunham 2000). Recent research (Whiteley et al. 2003) does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho.

Ecology / Habitat Characteristics – Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Howell and Buchanan 1992; Pratt 1992; Rich 1996; Rieman and McIntyre 1993; Rieman and McIntyre 1995; Sedell and Everest 1991; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), bull trout should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997).

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman et al. 1997; Rieman and McIntyre 1993). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and

McIntyre 1993; Spruell et al. 1999). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under “Diet.”

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) in the fall (Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1993).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Baxter et al. 1997; Pratt 1992; Rieman et al. 1997; Rieman and McIntyre 1993). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C (35 °F to 39 °F) whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (46 °F to 50 °F) (Buchanan and Gregory 1997; Goetz 1989; McPhail and Murray 1979). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C (46 °F to 48 °F), within a temperature gradient of 8 °C to 15 °C (4 °F to 60 °F). In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C (52 °F to 54 °F).

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997; Fraley and Shepard 1989; Rieman et al. 1997; Rieman and McIntyre 1993; Rieman and McIntyre 1995). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8 °C to 20 °C (46 °F to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Bart L. Gamett, Salmon-Challis National Forest, pers. comm. June 20, 2002).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Pratt 1992; Rich 1996; Sedell and Everest 1991; Sexauer and James 1997; Thomas 1992; Watson and Hillman 1997). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James

1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989; Pratt 1992; Pratt and Huston 1993). Pratt (1992) indicated that increases in fine sediment reduce egg survival and emergence.

Diet – Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987; Donald and Alger 1993; Goetz 1989). Subadult and adult migratory bull trout feed on various fish species (Brown 1994; Donald and Alger 1993; Fraley and Shepard 1989; Leathe and Graham 1982). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occurs in concentrated patches of abundance ("patch model"; Gerking 1994). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005; Goetz et al. 2004).

Historical status and distribution (summary) – The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978; Bond 1992). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Cavender 1978; Brewin et al. 1997).

Current status and distribution of the listed species in rangewide (summary) – Each of these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. No new local populations have been identified and no local populations have been lost since listing.

Jarbidge River Interim Recovery Unit – This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004b). The draft bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004b).

Klamath River Interim Recovery Unit – This interim recovery unit currently contains three core areas and seven local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002b). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002b). The draft Klamath River bull trout recovery plan (USFWS 2002b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations.

Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002b).

Columbia River Interim Recovery Unit –The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997, p.1177). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams. The draft Columbia River bull trout recovery plan (USFWS 2002d) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: dewatering; road construction and maintenance; mining; grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species. The Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USFWS 2005).

Coastal-Puget Sound Interim Recovery Unit – Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004a). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River Interim Recovery Unit – This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002c). Currently, bull trout are widely distributed in the St. Mary-Belly River drainage and occur in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002c). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002c). The draft St. Mary-Belly bull trout recovery plan (USFWS 2002c) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

e. **Threats; including reasons for listing, current rangewide threats –** Bull trout distribution, abundance, and habitat quality have declined rangewide (Bond 1992; Schill 1992; Thomas 1992; Ziller 1992; Rieman and McIntyre 1993; Newton and Pribyl 1994; McPhail and Baxter 1996). Several local extirpations have been documented, beginning in the 1950s (Rode 1990; Ratliff and Howell 1992; Donald and Alger 1993; Goetz 1994; Newton and Pribyl 1994; Light et al. 1996; Buchanan et al. 1997; WDFW 1998). Bull trout were extirpated from the southernmost portion of their historic range, the

McCloud River in California, around 1975 (Moyle 1976; Rode 1990). Bull trout have been functionally extirpated (i.e., few individuals may occur there but do not constitute a viable population) in the Coeur d'Alene River basin in Idaho and in the Lake Chelan and Okanogan River basins in Washington (63 FR 31647).

These declines result from the combined effects of habitat degradation and fragmentation, the blockage of migratory corridors; poor water quality, angler harvest and poaching, entrainment (process by which aquatic organisms are pulled through a diversion or other device) into diversion channels and dams, and introduced nonnative species. Specific land and water management activities that depress bull trout populations and degrade habitat include the effects of dams and other diversion structures, forest management practices, livestock grazing, agriculture, agricultural diversions, road construction and maintenance, mining, and urban and rural development (Beschta et al. 1987; Chamberlain et al. 1991; Furniss et al. 1991; Meehan 1991; Nehlsen et al. 1991; Sedell and Everest 1991; Craig and Wissmar 1993; Frissell 1993; Henjum et al. 1994; McIntosh et al. 1994; Wissmar et al. 1994; MBTSG 1995a-e, 1996a-f; Light et al. 1996).

Climate Change – Global climate change, and the related warming of global climate, have been well documented (IPCC 2007; ISAB 2007; WWF 2003). Evidence of global climate change/warming includes widespread increases in average air and ocean temperatures and accelerated melting of glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (IPCC 2007; Battin et al. 2007), we can no longer assume that climate conditions in the future will resemble those in the past.

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (ISAB 2007, Hari et al. 2006, Rieman et al. 2007). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (WWF 2003). The range of many species has shifted poleward and elevationally upward. For cold-water associated salmonids in mountainous regions, where their upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in range, which in turn can lead to a population decline (Hari et al. 2006).

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas. Higher air temperatures are also likely to increase water temperatures (ISAB 2007). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers.

Migratory bull trout can be found in lakes, large rivers and marine waters. Effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-warming impacts to lakes will likely lead to longer periods of thermal stratification and coldwater fish such as adfluvial bull trout will be restricted to these bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the bottom layers and intensify competition for food (WWF 2003).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change are related to shifts in timing, magnitude and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin et al. 2007). The increased magnitude of winter peak flows in high elevation areas is likely to impact the location, timing, and success of spawning and incubation for the bull trout and Pacific salmon species. Although lower elevation river reaches are not expected to experience as severe an impact from alterations in stream hydrology, they are unlikely to provide suitably cold temperatures for bull trout spawning, incubation and juvenile rearing.

As climate change progresses and stream temperatures warm, thermal refugia will be critical to the persistence of many bull trout populations. Thermal refugia are important for providing bull trout with patches of suitable habitat during migration through or to make feeding forays into areas with greater than optimal temperatures.

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007) although the scale of that variation may exceed that of States. For example, several studies indicate that climate change has the potential to impact ecosystems in nearly all streams throughout the State of Washington (ISAB 2007; Battin et al. 2007; Rieman et al. 2007). In streams and rivers with temperatures approaching or at the upper limit of allowable water temperatures, there is little if any likelihood that bull trout will be able to adapt to or avoid the effects of climate change/warming. There is little doubt that climate change is and will be an important factor affecting bull trout distribution. As its distribution contracts, patch size decreases and connectivity is truncated, bull trout populations that may be currently connected may face increasing isolation, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007). Due to variations in land form and geographic location across the range of the bull trout, it appears that some populations face higher risks than others. Bull trout in areas with currently degraded water temperatures and/or at the southern edge of its range may already be at risk of adverse impacts from current as well as future climate change.

2. **Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) –** Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), is an inland subspecies of cutthroat trout endemic to the physiographic Lahontan basin of northern Nevada, eastern California, and southern Oregon. It was initially listed as endangered under the Endangered Species Conservation Act of 1969 based on evidence of destruction and drastic modification of their habitat and hybridization with introduced species (35 Federal Register 13520). The species was reclassified as threatened in 1975 to facilitate management and allow regulated angling (40 Federal Register 29864). Critical habitat has not been designated for Lahontan cutthroat trout. The recovery plan for Lahontan cutthroat trout was published by the Service in January 1995. The species has been introduced into habitat outside of its native range, primarily for recreational fishing purposes.

   Lahontan cutthroat trout is one of 14 recognized subspecies of cutthroat trout in the western United States. Cutthroat trout have the most extensive range of any inland trout species of western North America, and occur in anadromous, non-anadromous, fluvial, and lacustrine populations (Behnke 1979). Many of the basins in which cutthroat trout occur contain remnants of much more extensive bodies of water which were present during the wetter period of the late Pleistocene epoch (Smith 1978).

   Differentiation of the species into 14 or so recognized subspecies occurred during subsequent general desiccation of the Great Basin and Inter-mountain Region since the end of the Pleistocene, and indicates presence of cutthroat trout in most of their historic range prior to the last major Pleistocene glacial advance (Behnke 1981; Loudenslager and Gall 1980). Ancestral Lahontan cutthroat trout probably invaded the pluvial Lake Lahontan system over 35,000 years ago (Gerstung 1986), although the precise events of entry and origin of original stock are unclear (Behnke 1979; Loudenslager and Gall 1980).

   Lahontan cutthroat trout evolved in a range of habitat types, from cold-water, high elevation streams to warmer, more alkaline lake environments. It is likely that localized, natural events historically caused the local extirpation of small populations of Lahontan cutthroat trout. Those events included landslides and rock fall, fires, drought, and debris flows that restricted movement. Lahontan cutthroat trout population persistence is associated with the ability to maintain connectivity among populations, (i.e., networked populations). A networked system is defined as an interconnected, stream and/or stream lake system in which individuals can migrate from or disperse into areas from which fish have been extirpated (Ray et. al. 2000). This ability to disperse and repopulate habitats allows populations to persist (Neville-Arsenault 2003; Dunham and Rieman 1999; Ray et. al. 2000; Dunham et. al. 1997). Periodic repopulation by upstream or downstream sources enabled Lahontan cutthroat trout to survive extreme circumstances and provided for genetic exchange (Neville-Arsenault 2003).

Lahontan cutthroat trout historically occurred in most cold waters of the Lahontan Basin of Nevada and California, including the Humboldt, Truckee, Carson, Walker, and Summit Lake/Quinn River drainages. Large alkaline lakes, small mountain streams and lakes, small tributary streams, and major rivers were inhabited, resulting in the present highly variable subspecies. The fish occurred in Tahoe, Pyramid, Winnemucca, Summit, Donner, Walker, and Independence Lakes, but disappeared from the type locality, Lake Tahoe, about 1940 due primarily to blockage of spawning tributaries, and subsequently from Pyramid and Walker Lakes (Behnke 1979). The subspecies has been extirpated from most of the western portion of its range in the Truckee, Carson and Walker River Basins, and from much of its historic range in the Humboldt Basin. Only remnant populations remain in a few streams in the Truckee, Carson, and Walker Basins out of an estimated 1,020 miles of historic habitat (Gerstung 1986).

In Oregon, Lahontan cutthroat trout historically occurred in Coyote Lake subbasin including Whitehorse, Little Whitehorse, Fifteenmile, Doolittle, and Cottonwood creeks, Willow Creek and its tributary, and Antelope Creek. Fifteenmile Creek fish are restricted by a natural barrier to the first 700 meters above the mouth. Antelope Creek was stocked in 1972 with trout from Whitehorse Creek and a small population remains.

Following a genetic and taxonomic evaluation of Willow-Whitehorse cutthroat trout, these populations were determined to be Lahontan cutthroat trout (Williams 1991). Willow-Whitehorse cutthroat were afforded protection and threatened status as Lahontan cutthroat trout on November 4, 1991. Sources and mechanisms of stream colonization outside of the Lahontan Basin by Lahontan cutthroat are uncertain, but human transport is suspected. Resident stream populations have subsequently been used to stock other Willow-Whitehorse area streams during the seventies and early eighties. These transplanted populations are considered threatened until they are determined to be "experimental populations" released outside of the native range of the species for conservation purposes.

The severe decline in range and numbers of Lahontan cutthroat trout is attributed to a number of factors, including hybridization and competition with introduced trout species; loss of spawning habitat due to pollution from logging, mining, and urbanization; blockage of streams by dams; channelization; de-watering from irrigation and urban water withdrawal; and watershed degradation due to overgrazing of domestic livestock (Gerstung 1986; Wydoski 1978). Minshall et al. (1989) state that the major human impacts on Great Basin streams are due to irrigated farming and livestock grazing. In the Humboldt Basin in Nevada, and Behnke (1979) attribute the poor condition of most stream habitats primarily to effects of extensive long-term livestock grazing. However, in the Truckee, Carson, and Walker Basins, Gerstung (1986) does not include effects of livestock grazing as a factor in the decline of Lahontan cutthroat trout, but includes pollution, over fishing, construction of dams and diversions, and competition and hybridization with non-native trout species.

3. **Borax Chub (*Gila boraxobius*) –** Borax Lake is a geothermally-heated alkaline lake located in a series of more than 150 hot springs along the Alvord Basin floor. The lake comprises 10 acres of surface water fed almost entirely by geothermal groundwater inflow (35 to 40 degrees C), and is surrounded by salt crusts and perched 30 feet above the surrounding desert.

The Borax Lake chub is endemic to Borax Lake and adjacent wetlands in Oregon's Alvord Basin. No other species of fish inhabit these waters. Borax Lake chub was formally described as a dwarf relative of the Alvord chub, which is widespread in the Alvord Basin (Williams and Bond 1980). The Borax Lake chub evolved from the Alvord chub when pluvial Lake Alvord receded, and fish were restricted to remaining springs, lakes and creeks. The fish that were restricted to Borax Lake were subject to extreme environmental conditions due to the geothermally-heated waters of Borax Lake, and thus they rapidly differentiated into the form now recognized as the Borax Lake chub.

The Borax Lake chub was listed as endangered in 1980 by emergency rule and again as endangered in 1982 by final rule pursuant to the Act. Primary threats at time of listing were potential impacts from geothermal energy development and diversion of the lake's outflows by alteration of the shoreline crust. The Borax Lake chub recovery plan was completed in 1987.

Critical habitat was designated on 640 acres of land surrounding the lake, including 320 acres of public lands and two 160-acre parcels of private lands. In 1983, the Bureau of Land Management (BLM) designated the public land around Borax Lake as an Area of Critical Environmental Concern. The Nature Conservancy began leasing the private lands in 1983, and purchased them in 1993.

Intensive population monitoring was conducted on this species from 1986 through 1997. Additional physical and biological monitoring occurred during this period. Monitoring was terminated in 1997 when the potential geothermal energy developer decided to abandon its plans in the area.

4. **Lost River Sucker *(Deltistes luxatus)***

Listing Status and Description – The Lost River sucker was listed as endangered by the U.S. Fish and Wildlife Service in 1988 (USDI 1988). Critical habitat has not been designated, but a new proposal was made in 2011 (USDI 2011a) and will be designated in 2012. The new proposal includes two proposed critical habitat (PCH) units for each species: the Upper Klamath Lake unit and the Lost River unit. The Lost River sucker is a large sucker that may reach over 0.9 m (3 ft.). It is characterized by a long, slender head with a sub terminal mouth and long, rounded snout (Moyle 2002). The coloring is dark on the back and sides, fading to white or yellow on the belly.

Population Trends and Distribution – The only species in the genus *Deltistes*, the Lost River sucker is native to Upper Klamath Lake and its tributaries and Clear Lake and its tributaries. Early records from the Upper Klamath River Basin indicate that the Lost River sucker was common and abundant. This sucker also historically inhabited the Lost River watershed, Tule Lake, Lower Klamath Lake, and Sheepy Lake (Moyle 2002), but is not considered native to the Klamath River, although it is now found there, at least downstream to Copco Reservoir (Beak Consultants Inc. 1987). The majority of the population occurs in Upper Klamath Lake and Clear Lake (Moyle 2002). Adults are primarily lake and impoundment residents that spawn in associated rivers, streams, or springs, including the Williamson and Sprague Rivers. They spawn in swift stretches with rubble or compacted cobble substrate, preferentially on loose gravel when available (Moyle 2002). They also spawn in spring inflows along the shore of Upper Klamath Lake. Spawning has been observed between March and early June.

Although sucker population sizes are unknown, based just on number of Lost River suckers captured in Upper Klamath Lake over the recent past (Hewitt et al. 2011), we assume there are currently approximately 10 thousand Lost River suckers and using the shoreline areas for spawning, and approximately 12 to 15 thousand spawning in the Williamson River system. Compounding the mortality rates for Lost River suckers using the shoreline areas indicates that their abundance has declined by 44-53 percent for males and 25-38 percent for females between 2002 and 2007 (Hewitt et al. 2011). Declines in Lost River suckers using the Williamson River for spawning over the same period is estimated to be 39 percent for males and 33 percent for females (Hewitt et al. 2011)

Reasons for Decline – Although a number of factors have contributed to the decline of the Lost River sucker, habitat degradation is considered the primary cause. Streams, rivers, and lakes have been modified by channelization and dams. Grazing in the riparian zone has eliminated streambank vegetation, and has added nutrients and sediment to river systems. Gilbert (1898) noted that the Lost River sucker was "the most important food-fish of the Klamath Lake region". Several commercial operations processed "enormous amounts" of suckers into oil, dried fish, canned fish, and other products (Andreasen 1975; Howe 1969). Wetland losses have been substantial (Larson and Brush 2010).

Recovery Measures – A recovery plan was published in 1993 (USDI 1993). A revised recovery plan was published in 2011 (USDI 2011b). Conservation efforts for the Lost River sucker focus on the re-establishment of a more naturally functioning ecosystem in the Klamath Basin. Fencing portions of streams to reduce cattle-caused erosion, replanting streambanks with native vegetation, improving forestry and agricultural practices, and assuring adequate water levels in reservoirs will contribute to the recovery of this species. Through coordination of the actions of land use agencies and private landowners, further degradation of sucker habitat can be avoided and steps can be taken to improve current conditions. By minimizing the impacts of future modifications to spawning habitat and restoring waters to a more natural state, recovery of Lost River sucker populations is possible in the Klamath Basin.

5. **Modoc Sucker**

Listing Status and Description – The Modoc sucker was listed as endangered June 11, 1985 (50 FR 24526), under the Endangered Species Act of 1973, as amended. The Modoc sucker is a relatively small member of the sucker family (Catostomidae), generally maturing around 8-10 centimeters (cm; 3-4 inches), and usually reaching only 18 cm (7 inches) in length. Breeding coloration is particularly marked in males, which develop a strong reddish-orange lateral stripe and intensified orange coloration on the caudal fin and paired fins (Moyle 2002). Modoc suckers are primarily found in relatively small (second- to fourth-order), perennial streams and occupy an intermediate zone between the high-gradient and higher elevation, coldwater trout zone and the low-gradient and low elevation, warm-water fish zone (Reid 2008). Most streams inhabited by Modoc sucker are characterized by moderate gradient (15-50 feet drop per mile), low summer flow (1-4 cubic feet per second), and relatively cool (59-72° F) summer temperatures (Moyle 2002). The pool habitat occupied by Modoc sucker generally includes fine sediments to small cobble bottoms, substantial detritus, and abundant in-water cover. Cover can be provided by overhanging banks, larger rocks, woody debris, and aquatic rooted vegetation or filamentous algae. Larvae occupy shallow vegetated margins and juveniles tend to remain free-swimming in the shallows of large pools, particularly near vegetated areas, while larger juveniles and adults remain mostly on, or close to, the bottom (Moyle 2002).

Demography and Population Trends – Several researchers have attempted to quantify the population size of Modoc sucker from their range in California and used these estimates to assess population trends. However, no population estimates have ever been conducted within Thomas Creek, Oregon. Nevertheless, surveys by Reid in 2001 and 2007 found the species to be common and widespread in Thomas Creek (Reid 2008).

Reasons for Decline – The principal remaining threat to the Modoc sucker is predation by non-native fishes, in particular brown trout in the Ash Creek sub-drainage and largemouth bass in the Turner sub-drainage (Reid 2008). While the Modoc sucker has survived for decades in the presence of non-native fish, if left unchecked introduced fish predators have the potential to threaten the Modoc sucker with local extinction in at least one of three sub-drainages. Additional work is needed to understand the effects of non-native fish to the survivability of Modoc suckers and to develop a long-term management plan to address these effects." Other reasons for decline include habitat modification, barriers to movement, hybridization with the Sacramento sucker, drought, and climate change.

6. **Shortnose Sucker *(Chasmistes brevirostris)***

Listing Status and Description – The shortnose sucker was listed as endangered by the U.S. Fish and Wildlife Service in 1988 (USDI 1988). Critical habitat has not been designated, but a new proposal was made in 2011 (USDI 2011a) and will be designated in 2012. The new proposal includes two proposed critical habitat units for each species: the Upper Klamath Lake unit and the Lost River unit. The shortnose sucker is characterized by a terminal mouth with thin lips having weak or no papillae (Moyle 2002). The shortnose sucker is primarily a lake resident that spawns in associated rivers, streams, or springs. Spawning runs have been observed from mid-April to mid-May and spawning occurs in over gravel and cobble bottoms (Moyle 2002).

Population Trends and Distribution – The current distribution of the shortnose sucker includes Upper Klamath Lake and its tributaries, Klamath River downstream to Iron Gate Reservoir, Clear Lake Reservoir and its tributaries, Gerber Reservoir and its tributaries, the Lost River, and Tule Lake (USDI 1988; Moyle 2002). Gerber Reservoir represents the only habitat with a shortnose sucker population that does not also have a Lost River sucker population. Its historic range likely also included Lake of the Woods and Lower Klamath Lake (Moyle 2002). Early records from the Upper Klamath River Basin indicate that the shortnose suckers were common and abundant. Several commercial operations processed "enormous amounts" of suckers into oil, dried fish, canned fish, and other products (Andreasen 1975; Howe 1968). Shortnose sucker abundance in Upper Klamath Lake declined by over 50 percent from 2001 to 2007 (Hewitt et al. 2011). Over that period, males declined by 58-80 percent and females by 52-73 percent (Hewitt et al. 2011).

Reasons for Decline – Although a number of factors have contributed to the decline of the shortnose sucker, habitat degradation is considered its primary cause. Streams, rivers, and lakes have been modified by channelization and dams. Grazing in the riparian zone has eliminated streambank vegetation, and has added nutrients and sediment to river systems.

Recovery Measures – A recovery plan was published in 1993. A revised recovery plan was published in 2011 (USDI 2011b). Conservation efforts for the shortnose sucker focus on the re-establishment of a more naturally functioning ecosystem in the Klamath Basin. Fencing portions of streams to reduce cattle-caused erosion, replanting streambanks with native vegetation, improving forestry and agricultural practices, and assuring adequate water levels in reservoirs will contribute to the recovery of this species.

7. **Warner Sucker (*Catostomus warnerensis*)**

Listing Status and Description – The FWS listed the Warner sucker as a threatened species and designated critical habitat on September 27, 1985 (USDI 1985a). The Warner sucker is a slender-bodied species that attains a maximum recorded fork length of 456 millimeters (17.9 inches). Pigmentation of sexually mature adults can be striking. The dorsal two-thirds of the head and body are blanketed with dark pigment, which borders creamy white lower sides and belly. During the spawning season, males have a brilliant red (or, rarely, bronze) lateral band along the midline of the body, female coloration is lighter.

Population Trends and Distribution – The probable historic range of the Warner sucker includes the main Warner Lakes (Pelican, Crump, and Hart), and other accessible standing or flowing water in the Warner Valley, as well as the low to moderate gradient reaches of the tributaries which drain into the Warner Valley. Warner sucker historic distribution in tributaries includes Deep Creek (up to the falls west of Adel), the Honey Creek drainage, and the Twentymile Creek drainage. In Twelvemile Creek, a tributary to Twentymile Creek, the historic range of Warner sucker extended through Nevada and back into Oregon. Stream resident populations of Warner sucker are found in Honey Creek, Snyder Creek, Twentymile Creek and Twelvemile Creek. Intermittent streams in the drainages may support small numbers of migratory suckers in high water years. No stream resident Warner sucker have been found in Deep Creek since 1983 (Smith et al. 1984, Allen et al. 1994), although a lake resident female apparently trying to migrate to stream spawning habitat was captured and released in 1990 (White et al. 1990). The known upstream limit of the Warner sucker in Twelvemile Creek is through the Nevada reach and back into Oregon (Allen et al. 1994).

Reasons for Decline – General stream channel and watershed degradation from livestock grazing has caused hydrologic impacts to sucker habitat. In addition, numerous small, agricultural diversion dams on creeks reduce stream flows and prevent migrations of adults and young. In lake habitats, non-native brown bullhead and crappie are abundant. The crappie and brown bullhead are presumed predators on young suckers.

Recovery Measures – Completed actions include fencing of streams to restore riparian vegetation, acquisition of ephemeral lake habitat, and construction of a fishway for passage over a diversion dam on Twentymile Creek. The Bureau of Land Management and the US Forest Service have altered their grazing and forest management practices to improve habitat for Warner suckers. Additional conservation measures needed include improving stream habitat and watershed conditions throughout the Warner Basin, re-establishing migration corridors, screening irrigation diversions, controlling exotic fishes, and maintaining adequate water supplies for fish.

Warner sucker critical habitat includes the following areas: Twelvemile Creek from the confluence of Twelvemile and Twentymile Creeks upstream for about six stream kilometers (four stream miles); Twentymile Creek starting about 14 kilometers (nine miles) upstream of the junction of Twelvemile and Twentymile Creeks and extending downstream for about 14 kilometers (nine miles); Spillway Canal north of Hart Lake and continuing about three kilometers (two miles) downstream; Snyder Creek, from the confluence of Snyder and Honey Creeks upstream for about five kilometers (three miles); Honey Creek from the confluence of Hart Lake upstream for about 25 k.

8. **Oregon Chub (*Oregonichthys crameri*) –** The Oregon chub is a small minnow (Family: Cyprinidae) endemic to the Willamette River drainage of western Oregon (Markle et al. 1991). Oregon chub evolved in a dynamic network of slack water habitats in the floodplain of the Willamette River. Major alteration of the Willamette River for flood control and navigation improvements has eliminated a large proportion of the river's historic floodplain. This alteration has also impaired or eliminated the environmental conditions in which the Oregon chub evolved. Many of the remaining suitable habitats have been invaded by non-native fish predators and competitors.

   Oregon chub are found in slack water off-channel habitats such as beaver ponds, oxbows, side channels, backwater sloughs, low gradient tributaries, and flooded marshes. These habitats usually have little or no water flow, silty and organic substrate, and considerable aquatic vegetation as cover for hiding and spawning (Pearsons 1989, Markle et al. 1991, Scheerer and McDonald 2000). The average depth of Oregon chub habitats is typically less than two meters (six feet) and the summer temperatures typically exceed 16 degrees Celsius (61 degrees Fahrenheit). Adult Oregon chub seek dense vegetation for cover and frequently travel in the mid-water column in beaver channels or along the margins of aquatic plant beds. Larval chub congregate in near shore areas in the upper layers of the water column in shallow areas (Pearsons 1989, Scheerer 1997). Juvenile Oregon chub venture farther from shore into deeper areas of the water column (Pearsons 1989). In the winter months, Oregon chub can be found buried in the detritus or concealed in aquatic vegetation (Pearsons 1989). Fish of similar size classes school and feed together. In the early spring, Oregon chub are most active in the warmer, shallow areas of the ponds.

   Oregon chub spawn from April through September. Before and after spawning season, chub are social and non-aggressive. Spawning activity has only been observed at temperatures exceeding 16 degrees Celsius (61 degrees Fahrenheit). Males over 35 millimeters (1.4 inches) have been observed exhibiting spawning behavior (Pearsons 1989).

   Oregon chub are obligatory sight feeders (Davis and Miller 1967). They feed throughout the day and stop feeding after dusk (Pearsons 1989). Chub feed mostly on water column fauna. The diet of Oregon chub adults collected in a May sample consisted primarily of minute crustaceans including copepods, cladocerans, and chironomid larvae (Markle et al. 1991). The diet of juvenile chub also consists of minute organisms such as rotifers, copepods, and cladocerans (Pearsons 1989).

   The action area includes all streams, rivers, ponds, reservoirs, and other bodies of water within the Willamette River Basin, which as noted above constitutes the entire historic range for the chub, since they are endemic to the Willamette River drainage. Provided below is a summary of the actions currently contributing to the environmental baseline for Oregon chub.

Oregon chub are restricted to the Willamette River drainage, including the Santiam, Coast Fork Willamette, Middle Fork Willamette, Long Tom, Mohawk, and McKenzie Rivers and their tributaries. Historically, the rivers meandered freely within the main floodplain and likely changed courses frequently as flood events occurred, especially prior to construction of numerous dams in the river systems in the 1950's and 1960's. The presence of the dams has altered the flood regime, reduced the amount of available chub habitat, and restricted chub access to existing habitat. The proliferation of introduced predators and competitors in these systems (e.g., largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), crappie (*Pomoxus sp*.), and mosquitofish (*Gambusia affinis*)) has posed an additional and significant threat to Oregon chub. Other threats include illegal water withdrawals, unauthorized fill and removal activities, timber harvest, highway and pipeline construction, roadside herbicide applications, chemical spills, and routine culvert maintenance operations (50 CFR 53800, October 18, 1993).

At present, Oregon chub occur at approximately 29 locations, including 21 naturally occurring populations and eight introduced populations (Scheerer *et al.* 2004). All populations exist within the Willamette River system and its tributaries. The naturally occurring populations are found in the North and mainstem Santiam River, Middle Fork Willamette River, McKenzie River, and the mid-Willamette drainages. Eight populations of Oregon chub have been introduced into habitats within the Willamette Basin at Wicopee Pond, Fall Creek Spillway Pond, Foster Pullout Pond, Dunn Wetland, Finley Display Pond, Cheadle Pond, Herman Pond, and Russell Pond. In addition, two introductions were conducted during 2004 at Jampolsky Pond and Ankeny Willow Marsh. In 2004, 15 populations of Oregon chub were larger than 500 individuals. Twelve of these populations exhibited stable or increasing trends over the last five years. Oregon chub appear to have been extirpated from 14 locations at which they were detected in the 1990’s (Scheerer et al. 2004).

Of the 29 known Oregon chub populations, the sites with the highest diversity of native fish, amphibian, and reptile species have the largest populations of Oregon chub (Scheerer and McDonald 2000). Beaver (*Castor canadensis*) appear to be especially important in creating and maintaining habitats that support these diverse native species assemblages. In contrast, sites with high abundance of exotic predaceous fish species, particularly centrarchids (bass, bluegills, crappies, and others) have few to no Oregon chub.

A variety of Federal actions have been the subject of section 7 consultation on Oregon chub. These include dam re-licensing, fish screen installation/upgrades, fish passageways, mining, road and bridge construction and maintenance, wastewater treatment plant operations, dredging, scientific studies, and habitat restoration. The majority of the effects of these actions on Oregon chub have been “no effect” or “not likely to adversely effect.” A small number of consultations have resulted in “likely to adversely affect” determinations in the short term, but with anticipated long term benefits to the species (e.g., section 10(a) (1) (A) recovery permits, habitat restorations). The Service is currently consulting with the U.S. Army Corps of Engineers on the hydroelectric operations in the Willamette Valley, which has resulted in a "likely to adversely affect" determination. There have also been numerous technical assistance consultations.

9. **Foskett Speckled Dace (*Rhinichthys osculus*)** – The Foskett speckled dace is endemic to one spring on the western margin of Coleman Lake, Lake County, Oregon. The Foskett speckled dace was listed as threatened in 1985 (USDI 1985b). Population size and age structure for this species were last assessed in 1997, by ODFW (Dambacher *et al.* 1997). The recovery plan for Foskett speckled dace was finalized in 1998 (USDI 1998c). No critical habitat has been designated or proposed for the Foskett speckled dace.

   Little is known about the biology or ecology of the Foskett speckled dace. Foskett Spring is a cool-water spring with temperatures recorded at a constant 18 degrees Celsius over a 2-year period. No information is available on growth rates, age of reproduction, or behavioral patterns. Monitoring has been limited since 1997 to periodic inspection of the dace habitat, along with photo point and vegetation sampling by the Lakeview District BLM.

   The Foskett speckled dace is an allopatric form that is currently being described (hence, it has not yet received a subspecific name). Despite the undescribed status there is information regarding its identification. The Foskett dace can be distinguished from other speckled dace by external characteristics, such as: much reduced lateral line, about 15 scales with pores; about 65 lateral line scales; a large eye; the dorsal fin is positioned well behind the pelvic fin but before the beginning of the anal fin; barbels are present on most individuals (USDI 1998c).

   The timing of the isolation between the Warner Lakes Subbasin and the Coleman Subbasin is uncertain although it might be as recent as 10,000 years ago (Bills 1977). Foskett speckled dace were probably distributed throughout prehistoric (approximately 12,000 years ago) Coleman Lake during times that it held substantial amounts of water. As the lake dried, the salt content of the lake water increased. Suitable habitat would have been reduced from a large lake to any spring systems that provided enough suitable habitat for survival.

   Springs that remain within the vicinity of Coleman Lake include Foskett Spring and Dace Spring. Both springs are extremely small and shallow with limited habitat for fish. Foskett Spring has the only known native population of Foskett speckled dace. The spring originates in a pool about 5 meters (16.6 feet) across, then flows toward Coleman Lake in a narrow, shallow channel (approximately 5 centimeters (2 inches) deep and 5 centimeters (2 inches) wide). The source pool has a loose sandy bottom and is choked with macrophytes. The spring brook (outflow channel) eventually turns into a marsh and dries up before reaching the bed of Coleman Lake. Bond (USDI 1985b) estimated the population of Foskett speckled dace in Foskett Spring to be approximately 1,500 individuals. Dambacher et al. (1997) estimated 204 Foskett speckled dace in the source pool, 702 in the spring brook, and 26,881 in the shallow pool/marsh. This habitat is outside the exclosure fence and dries periodically.

Dace Spring is approximately 0.8 kilometer (0.5 mile) south of Foskett Spring. This spring may have originally been occupied by Foskett speckled dace but there were none found in the 1970's. In November 1979, 50 Foskett speckled dace were transplanted into the then fishless Dace Spring from Foskett Spring (Williams et al. 1990). In August 1980, 50 more Foskett speckled dace were introduced into Dace Spring. Dace Spring is smaller than Foskett Spring and even more choked with macrophytes. The spring outflow terminates in a cattle watering trough where fewer than 20 Foskett speckled dace were seen in 1996 (Dambacher et al. 1997). The watering trough is at approximately the same height/elevation as the spring head with a pipe entering into the side of the trough. This allows the fish access into the trough, but does not allow the fish to return to the spring.

Current management of the Foskett and Dace spring systems excludes livestock use. Proposals to burn dense vegetation, place flow-monitoring weirs, and pen water pools have yet to be implemented or fully evaluated.

B. Fish Species under the Jurisdiction of the NMFS

(Species descriptions were provided by the NMFS Oregon State Office)

1. **Puget Sound Recovery Domain.** Species in the PS recovery domain include PS Chinook salmon, HC summer-run chum salmon, LO sockeye salmon, PS steelhead, southern green sturgeon, and eulachon. The PS TRT has identified 22 extant demographically-independent populations of Chinook salmon, two of summer-run chum salmon,[3] one of sockeye salmon, and one of coho salmon[4] (Ford 2011) (Table 15). These populations were further aggregated into strata, groupings above the population level that are connected by some degree of migration, based on ecological subregions. The PS steelhead TRT has not yet finalized its viability criteria for the PS steelhead DPS and is still conducting analyses to identify populations and MPGs within the DPS. The PS-TRT has not yet addressed southern green sturgeon or eulachon.

[3] One HC chum salmon population has four extant spawning aggregations and one has 10 extant spawning aggregations; some of these are recently reintroduced. Spawning aggregations are also referred to as subpopulations.

[4] The 1995 status review for PS coho (Weitkamp et al. 1995) was never finalized due to a request by co-managers for further review and comment. At present, PS/Strait of Georgia coho salmon are not listed as an endangered species, but remain a species of concern (USDC 2004).

Table 15 – Numbers of historical and extant populations for ESA-listed salmon and steelhead in the PS recovery domain (Ford 2011).

Species	Historical Populations	Extant Populations
PS Chinook salmon	31	22
HC summer-run chum salmon	18	2
LO sockeye salmon	1	1
PS steelhead	Not available	

a. **Status of PS Chinook Salmon –** Spatial Structure and Diversity. This species includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington, and progeny of 26 artificial propagation programs. The PS-TRT identified 22 historical populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 16). The NMFS adopted the Shared Strategy for Puget Sound locally-developed listed species recovery plan for PS Chinook salmon in 2007 (SSPS 2007).

Indices of spatial distribution and diversity have not been developed at the population level. Based on a Shannon Diversity Index at the ESU level, diversity is declining (due primarily to the increased abundance of returns to the Whidbey Basin region) for both distribution among populations and among regions (Ford 2011). Overall, the new information on abundance, productivity, spatial structure and diversity since the 2005 status review does not indicate a change in the biological risk category (Ford 2011).

Table 16 – Extant PS Chinook salmon populations in each geographic region (Ford 2011).

Geographic Region	**Population (Watershed)**
Strait of Georgia	North Fork Nooksack River
	South Fork Nooksack River
Strait of Juan de Fuca	Elwha River
	Dungeness River
Hood Canal	Skokomish River
	Mid Hood Canal River
Whidbey Basin	Skykomish River
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River

Table 16 (continued)– Extant PS Chinook salmon populations in each geographic region (Ford 2011).

Whidbey Basin	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

Abundance and Productivity. No trend was notable for the total ESU escapements; while trends vary from decreasing to increasing among populations. Natural-origin pre-harvest recruit escapements remained fairly constant from 1985-2009. Returns (pre-harvest run size) from the natural spawners were highest in 1985, declined through 1994, remained low through 1999, increased in 2000 and again in 2001, and have declined through 2009, with 2009 having the lowest returns since 1997. Median recruits per spawner for the last 5-year period (brood years 2002-2006) is the lowest over any of the 5-year intervals. Many of the habitat and hatchery actions identified in the Puget Sound Chinook salmon recovery plan are likely to take years or decades to be implemented and to produce significant improvements in natural population attributes, and these trends are consistent with these expectations (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; Shared Strategy for Puget Sound 2007):

(i) Degraded nearshore and estuarine habitat: Residential and commercial development has reduced the amount of functioning nearshore and estuarine habitat available for salmon rearing and migration. The loss of mudflats, eelgrass meadows, and macroalgae further limits salmon foraging and rearing opportunities in nearshore and estuarine areas.

(ii) Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, and water quality have been degraded for adult spawning, embryo incubation, and rearing as a result of cumulative impacts of agriculture, forestry, and development.

(iii) Anadromous salmonid hatchery programs: Salmon and steelhead released from Puget Sound hatcheries operated for harvest augmentation purposes pose ecological, genetic, and demographic risks to natural-origin Chinook salmon populations.

(iv) Salmon harvest management: Total fishery exploitation rates have decreased 14 to 63% from rates in the 1980s, but weak natural-origin

Chinook salmon populations in Puget Sound still require enhanced protective measures to reduce the risk of overharvest in Chinook salmon-directed fisheries.

b. Status of HC Summer-run Chum Salmon – Spatial Structure and Diversity. This species includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries; populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington; and progeny of eight artificial propagation programs. The Strait of Juan de Fuca population spawns in rivers and streams entering the eastern Strait and Admiralty Inlet. The Hood Canal population includes all spawning aggregations within the Hood Canal area (Hood Canal Coordinating Council 2005; NMFS 2007b). The PS-TRT identified two independent populations of Hood Canal summer chum salmon (NMFS 2007c), which include 16 historical stocks or spawning aggregations (including eight that are extant), based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 17). The historical populations included at least those 16 spawning aggregation units and likely some additional undocumented and less-persistent aggregations (NMFS 2007c). Programs are underway to reintroduce summer-run chum salmon to several of the watersheds where stocks were lost.

Table 17 – HC summer-run chum salmon populations (geographic regions), population aggregations, and their status (Ford 2011).

Geographic Region (Population)	Stock (Watershed)	Status
Strait of Juan de Fuca	Dungeness River	Unknown <5 adult returns annually recently
	Jimmycomelately Creek	Extant
	Salmon River	Extant
	Snow River	Extant
	Chimacum Creek	Extinct but reintroduced with natural spawning reported starting in 1999
Hood Canal	Big Quilcene River	Extant
	Little Quilcene River	Extant
	Dosewallips River	Extant
	Duckabush River	Extant
	Hamma Hamma River	Extant
	Lilliwaup Creek	Extant
	Big Beef Creek	Extinct but reintroduced with adult returns reported starting in 2001
	Anderson Creek	Extinct
	Dewatto Creek	Extinct, no returns mid 1990’s, some natural recolonization apparent but numbers remain low (<70 annually)
	Tahuya River	Extinct but reintroduced with increased adult returns reported starting 2006
	Union River	Extant

Table 17 (continued) – HC summer-run chum salmon populations (geographic regions), population aggregations, and their status (Ford 2011).

Hood Canal	Skokomish River	Extinct; no spawning reported prior to 2001; very low numbers of adult returns (<40 annually) reported in recent years
	Finch Creek	Extinct

Diversity is increasing from the low values seen in the 1990s, due both to the reintroduction of spawning aggregates and the more uniform relative abundance between populations; this is a good sign for viability in terms of spatial structure and diversity. Spawning survey data shows that the spawning distribution within most streams has been extended farther upstream as abundance has increased (WDFW and Point No Point Treaty Tribes 2007). Estimates of population viability from three time periods (brood years 1971-2006, 1985-2006, and 1990-2006) all indicate that Hood Canal and Strait of Juan de Fuca populations of summer-run chum salmon are not currently viable (Ford 2011).

Abundance and Productivity. Overall, the new information considered does not indicate a change in the biological risk category since the last status review in 2005 (Ford 2011). The spawning abundance of this species has clearly increased since the time of listing, although the recent abundance is down from the previous 5 years. However, productivity in the last 5-year period (2002-2006) has been very low, especially compared to the relatively high productivity in the 5-10 previous years (WDFW and Point No Point Treaty Tribes 2007). This is a concern for viability. Since abundance is increasing and productivity is decreasing, improvements in habitat and ecosystem function likely are needed.

Limiting factors include (Hood Canal Coordinating Council 2005; NMFS 2007b; NOAA Fisheries 2011):

- Nearshore and estuarine habitat throughout the range of the species has been altered by human activities. Nutrient loading has lowered dissolved oxygen concentrations, which can kill or stress marine organisms, including salmon. Residential and commercial development has reduced the amount of functioning habitat available for salmon rearing and migration. The loss of mudflats, eelgrass meadows, and macroalgae further limits salmon foraging and rearing opportunities in nearshore and estuarine areas.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, and stream flow have been degraded as a result of cumulative impacts of agriculture, forestry, and development.

c. **Status of LO Sockeye Salmon –** Spatial Structure and Diversity. This species includes all naturally spawned populations of sockeye salmon in Ozette Lake and streams and tributaries flowing into Ozette Lake, Washington, and progeny of two artificial propagation programs. The LO Technical Recovery Team concluded that five extant spawning aggregations in Ozette Lake are different subpopulations within a single population (Currens et al. 2009; NMFS 2009a). The subpopulations can be grouped according to whether they spawn in tributaries or near lake beaches (NMFS 2009a).

Abundance and Productivity. LO sockeye salmon population sizes remain very small compared to historical sizes. Additionally, population estimates remain highly variable and uncertain, making it impossible to detect changes in abundance trends or in productivity in recent years. The most recent brood years (1999-2003) have had the lowest average recruits per spawner. Spatial structure and diversity are also difficult to appraise; there is currently no successfully quantitative program to monitor beach spawning or spawning at other tributaries. Assessment methods must improve to evaluate the status of this species and its responses to recovery actions. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting factors include (NMFS 2009a; NOAA Fisheries 2011; USDC 2009): Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, lake beach spawning habitat, and stream substrate have been degraded as a result of cumulative impacts of forest practices, agriculture, and development.

Predation: Harbor seals and river otters, and predaceous non-native and native fish species, are reducing the abundance of adult fish that successfully spawn, and the abundance of sockeye smolts escaping seaward from the watershed each year.

d. Status of PS Steelhead – Spatial Structure and Diversity – Steelhead populations can be divided into two basic reproductive ecotypes, based on the state of sexual maturity at the time of river entry (summer or winter) and duration of spawning migration (Burgner *et al.* 1992) (Table 18). The PS DPS includes all naturally spawned anadromous winter-run and summer-run steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), as well as the Green River natural and Hamma Hamma winter-run steelhead hatchery stocks. Non-anadromous ‘‘resident’’ *O. mykiss* occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al. 2007; USDC 2007).

Table 18 – PS steelhead populations and risk of extinction (Ford 2011).

Geographic Region (MPGs)	Population (Watershed)	Extinction Risk (probability of decline to 10% of its current estimated abundance)
Northern Cascades	Samish River (winter)	High—about 80% within 25 years
	Skagit River (winter)	High—about 80% within 75 years.
	Snohomish River (winter)	Moderately High—about 50% within 100 years
	Stillaguamish River (winter)	High—about 90% within 60 years
	Tolt River summer	High—nearly 80% within 100 years
	Nooksack River (winter)	Unable to calculate
South Puget Sound	Lake Washington (winter)	High—~ 90% within 40 years
	Green River (winter)r	High—about 90% within 80 years
	Nisqually River (winter)	High—about 80% within 40 years
	Puyallup River (winter)	High—about 90% within 25-30 years
	White River (winter)	High—about 90% within 50 years
	South Sound Tributaries (winter)	Unable to calculate
Olympic	Elwha River (winter)	Fairly High— ~ 90% within 40 years
	Dungeness River (winter)	High—within 100 years (population too low to calculate %)
	Port Angeles (winter)	High—nearly 80% within 100 years
	West Hood Canal (winter)	Low—near zero within 100 years
	East Hood Canal (winter)	Low—about 30% within 100 years
	Skokomish River (winter)	High—about 80% within 80 years

The Puget Sound Steelhead TRT has completed a set of simple population viability analyses (PVAs) for these draft populations and MPGs within the DPS. No new estimates of productivity, spatial structure and diversity of PS steelhead have been made available since the 2007 review, when the BRT concluded that low and declining abundance and low and declining productivity were substantial risk factors for the species (USDC 2007). Loss of diversity and spatial structure were judged to be "moderate" risk factors. Since the listing of this species, this threat has not changed appreciably (Ford 2011).

Abundance and Productivity. The BRT considered the major risk factors facing Puget Sound steelhead to be: widespread declines in abundance and productivity for most natural steelhead populations in the ESU, including those in Skagit and Snohomish rivers (previously considered to be strongholds); the low abundance of several summer-run populations; and the sharply diminishing abundance of some steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca (Hard et al. 2007). For all but a few putative PS steelhead populations, estimates of mean population growth rates obtained from observed spawner or redd counts are declining—typically 3 to 10% annually—and extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for draft populations in the putative South Sound and Olympic MPGs. Most populations within the DPS continue downward trends in estimated abundance, a few sharply so. Extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for populations in the South Sound and Olympic MPGs.

Limiting factors include (NOAA Fisheries 2011):

- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years.
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania) inconsistent with wild stock diversity throughout the DPS.
- Declining diversity in the DPS, including the uncertain but weak status of summer-run fish in the DPS.
- A reduction in spatial structure for steelhead in the DPS.
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris.
- Increased flood frequency and peak flows during storms, reduced groundwater-driven summer flows in the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, has resulted in gravel scour, bank erosion, and sediment deposition.
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, have increased the likelihood of gravel scour and dislocation of rearing juveniles.

e. **Status of Southern DPS Green Sturgeon –** Spatial Structure and Diversity. Two DPSs have been defined for green sturgeon (*Acipenser medirostris*), a northern DPS (spawning populations in the Klamath and Rogue rivers) and a southern DPS (spawners in the Sacramento River). Southern green sturgeon includes all naturally-spawned populations of green sturgeon that occur south of the Eel River in Humboldt County, California. When not spawning, this anadromous species is broadly distributed in nearshore marine areas from Mexico to the Bering Sea. Although it is commonly observed in bays, estuaries, and sometimes the deep riverine mainstem in lower elevation reaches of non-natal rivers along the west coast of North America, the distribution and timing of estuarine use are poorly understood.

In addition to the PS recovery domain, southern green sturgeon occur in the Willamette and Lower Columbia (WLC), Oregon Coast (OC), and Southern Oregon/Northern California Coasts (SONCC) recovery domains. However, green sturgeon habitat in the PS recovery area was not designated as critical habitat.

Limiting factors. The principal factor for the decline of southern green sturgeon is the reduction of its spawning area to a single known population limited to a small portion of the Sacramento River. It is currently at risk of extinction primarily because of human-induced ‘‘takes’’ involving elimination of freshwater spawning habitat, degradation of freshwater and estuarine habitat quality, water diversions, fishing, and other causes (USDC 2010). Adequate water flow and temperature are issues of concern. Water diversions pose an unknown but potentially serious threat within the Sacramento and Feather Rivers and the Sacramento River Delta. Poaching also poses an unknown but potentially serious threat because of high demand for sturgeon caviar. The effects of contaminants and nonnative species are also unknown but potentially serious threats. As mentioned above, retention of green sturgeon in both recreational and commercial fisheries is now prohibited within the western states, but the effect of capture/release in these fisheries is unknown. There is evidence of fish being retained illegally, although the magnitude of this activity likely is small (NOAA Fisheries 2011).

f. **Status of Southern DPS Eulachon –** Spatial Structure and Diversity. The southern distinct population segment of eulachon occur in four salmon recovery domains: Puget Sound, the Willamette and Lower Columbia, Oregon Coast, and Southern Oregon/Northern California Coasts. The ESA-listed population of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Core populations for this species include the Fraser River, Columbia River and (historically) the Klamath River. Eulachon leave saltwater to spawn in their natal streams late winter through early summer, and typically spawn at night in the lower reaches of larger rivers fed by snowmelt. After hatching, larvae are carried downstream and widely dispersed by estuarine and ocean currents. Eulachon movements in the ocean are poorly known although the amount of eulachon bycatch in the pink shrimp fishery seems to indicate that the distribution of these organisms overlap in the ocean.

Abundance and Productivity. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River with no evidence of returning to their former population levels since then (Drake et al. 2008). Persistent low returns and landings of eulachon in the Columbia River from 1993 to 2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan in 2001 that provides for restricted harvest management when parental run strength, juvenile production, and ocean productivity forecast a poor return (WDFW and ODFW 2001). Despite a brief period of improved returns in 2001–2003, the returns and associated commercial landings have again declined to the very low levels observed in the mid-1990s (Joint Columbia River Management Staff 2009), and since 2005, the fishery has operated at the most conservative level allowed in the management plan (Joint Columbia River Management Staff 2009). Large commercial and recreational fisheries have occurred in the Sandy River in the past. The most recent commercial harvest in the Sandy River was in 2003. No commercial harvest has been recorded for the Grays River from 1990 to the present, but larval sampling has confirmed successful spawning in recent years (USDC 2011).

Limiting Factors include (Gustafson et al. 2010; Gustafson et al. 2011; NOAA Fisheries 2011):

- Changes in ocean conditions due to climate change, particularly in the southern portion of its range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success.
- Climate-induced change to freshwater habitats, dams and water diversions (particularly in the Columbia and Klamath Rivers where hydropower generation and flood control are major activities)
- Bycatch of eulachon in commercial fisheries
- Adverse effects related to dams and water diversions
- Artificial fish passage barriers
- Increased water temperatures, insufficient streamflow
- Altered sediment balances
- Water pollution
- Over-harvest
- Predation

B. **Willamette-Lower Columbia Recovery Domain.** Species in the Willamette-Lower Columbia (WLC) Recovery Domain include LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, UWR steelhead, southern green sturgeon, and eulachon. The WLC-TRT has identified 107 demographically independent populations of Pacific salmon and steelhead (Table 19). These populations were further aggregated into strata, groupings above the population level that are connected by some degree of migration, based on ecological subregions. All 107 populations use parts of the mainstem of the Columbia River and the Columbia River estuary for migration, rearing, and smoltification.

Table 19 – Populations in the WLC recovery domain. Combined extinction risks for salmon and steelhead based on an analysis of Oregon populations.

Species	Populations
LCR Chinook salmon	32
UWR Chinook salmon	7
CR chum salmon	17
LCR coho salmon	24
LCR steelhead	23
UWR steelhead	4

a. ***Status of LCR Chinook Salmon*** **–** Spatial Structure and Diversity. This species includes all naturally-spawned populations of Chinook salmon in the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River; the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas

River; and progeny of seventeen artificial propagation programs.[5] LCR Chinook populations exhibit three different life history types base on return timing and other features: fall-run (a.k.a. "tules"), late-fall-run (a.k.a. "brights"), and spring-run. The WLC-TRT identified 32 historical populations of LCR Chinook salmon— seven in the coastal subregion, six in the Columbia Gorge, and 19 in the Cascade Range (Table 20). Spatial structure has been substantially reduced in several populations. Low abundance, past broodstock transfers and other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (Lower Columbia Fish Recovery Board 2010; ODFW 2010). Out of the 32 populations that make up this ESU, only the two late-fall runs—the North Fork Lewis and Sandy—are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years (and some are extirpated or nearly so) (Ford 2011; Lower Columbia Fish Recovery Board 2010; ODFW 2010). Five of the six strata fall significantly short of the WLC-TRT criteria for viability; one stratum, Cascade late-fall, meets the WLC TRT criteria (NMFS 2012a).

Table 20 – LCR Chinook salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NMFS 2012a). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		**Spawning Population (Watershed)**	**A&P**	**Spatial Structure**	**Diversity**	**Overall Persistence Probability**
Ecological Subregion	**Run Timing**					
Cascade Range	Spring	Upper Cowlitz River (WA)	VL	L	M	VL
		Cispus River (WA)	VL	L	M	VL
		Tilton River (WA)	VL	VL	VL	VL
		Toutle River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		North Fork Lewis (WA)	VL	L	M	VL
		Sandy River (OR)	M	M	M	M
	Fall	Lower Cowlitz River (WA)	VL	H	M	VL
		Upper Cowlitz River (WA)	VL	VL	M	VL
		Toutle River (WA)	VL	H	M	VL
		Coweeman River (WA)	L	H	H	L
		Kalama River (WA)	VL	H	M	VL
		Lewis River (WA)	VL	H	H	VL
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	VL	VH	L	VL
		Sandy River (OR)	VL	M	L	VL

[5] In 2009, the Elochoman tule fall Chinook salmon program was discontinued and four new fall Chinook salmon programs have been initiated. In 2011, NMFS recommended removing the Elochoman program from the ESU and adding the new programs to the ESU (NMFS 2011a).

Table 20 (continued) – LCR Chinook salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NMFS 2012a). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Cascade Range		Washougal River (WA)	VL	H	M	VL
	Late Fall	North Fork Lewis (WA)	VH	H	H	VH
		Sandy River (OR)	VH	M	M	VH
Columbia Gorge	Spring	White Salmon River (WA)	VL	VL	VL	VL
		Hood River (OR)	VL	VH	VL	VL
	Fall	Lower Gorge (WA & OR)	VL	M	L	VL
		Upper Gorge (WA & OR)	VL	M	L	VL
		White Salmon River (WA)	VL	L	L	VL
		Hood River (OR)	VL	VH	L	VL
Coast Range	Fall	Young Bay (OR)	L	VH	L	L
		Grays/Chinook rivers (WA)	VL	H	VL	VL
		Big Creek (OR)	VL	H	L	VL
		Elochoman/Skamokawa creeks (WA)	VL	H	L	VL
		Clatskanie River (OR)	VL	VH	L	VL
		Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
		Scappoose River (OR)	L	H	L	L

Abundance and Productivity. A&P ratings for LCR Chinook salmon populations are currently “low” to “very low” for most populations, except for spring Chinook salmon in the Sandy River, which are “moderate” and late-fall Chinook salmon in North Fork Lewis River and Sandy River, which are “very high” (NMFS 2012a). Low abundance of natural-origin spawners (100 fish or fewer) has increased genetic and demographic risks. Other LCR Chinook salmon populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners. Particularly for tule fall Chinook salmon populations, poor data quality prevents precise quantification of population abundance and productivity; data quality has been poor because of inadequate spawning surveys and the presence of unmarked hatchery-origin spawners (Ford 2011).

Limiting Factors include (NMFS 2012a; NOAA Fisheries 2011):

(i) Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.

(ii) Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects

(iii)Hatchery-related effects

(iv) Harvest-related effects on fall Chinook salmon
(v) An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
(vi) Reduced access to off-channel rearing habitat in the lower Columbia River
(vii) Reduced productivity resulting from sediment and nutrient-related changes in the estuary
(viii) Juvenile fish strandings that result from ship wakes
(ix) Contaminants affecting fish health and reproduction

b. ***Status of UWR Chinook Salmon*** **–** Spatial Structure and Diversity. This species includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River; in the Willamette River and its tributaries above Willamette Falls, Oregon; and progeny of seven artificial propagation programs. All seven historical populations of UWR Chinook salmon identified by the WLC-TRT occur within the action area and are contained within a single ecological subregion, the western Cascade Range (Table 21). The McKenzie River population currently characterized as at a "low" risk of extinction and the Clackamas population has a "moderate" risk. (Ford 2011). Consideration of data collected since the last status review in 2005 has confirmed the high fraction of hatchery origin fish in all of the populations of this species (even the Clackamas and McKenzie rivers have hatchery fractions above WLC-TRT viability thresholds). All of the UWR Chinook salmon populations have "moderate" or "high" risk ratings for diversity. Clackamas River Chinook salmon have a "low" risk rating for spatial structure (Ford 2011).

Table 21 – Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR Chinook salmon (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk
Clackamas River	M	M	L	M
Molalla River	VH	H	H	VH
North Santiam River	VH	H	H	VH
South Santiam River	VH	M	M	VH
Calapooia River	VH	H	VH	VH
McKenzie River	VL	M	M	L
Middle Fork Willamette River	VH	H	H	VH

Abundance and Productivity. The Clackamas and McKenzie river populations currently have the best risk ratings for A&P, spatial structure, and diversity. Data collected since the BRT status update in 2005 highlighted the substantial risks associated with pre-spawning mortality. Although recovery plans are targeting key limiting factors for future actions, there have been no significant on-the-ground-actions since the last status review to resolve the lack of access to historical habitat above dams nor have there been substantial actions removing hatchery fish from the spawning grounds. Overall, the new information does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011):

- Significantly reduced access to spawning and rearing habitat because of tributary dams
- Degraded freshwater habitat, especially floodplain connectivity and function, channel structure and complexity, and riparian areas and large wood recruitment as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Hatchery-related effects
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation on, and competition with, native UWR Chinook salmon
- Ocean harvest rates of approximately 30%

c. ***Status of CR Chum Salmon*** **–** Spatial Structure and Diversity. This species includes all naturally-spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon, and progeny of three artificial propagation programs. The WLC-TRT identified 17 historical populations of CR chum salmon and aggregated these into four strata (Myers et al. 2006) (Table 22). CR chum salmon spawning aggregations identified in the mainstem Columbia River were included in the population associated with the nearest river basin.

Table 22 – CR chum salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2012a). Persistence probability ratings are very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		Spawning Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Persistence Probability
Ecological Subregion	**Run Timing**					
Coast Range	Fall	Young's Bay (OR)	*	*	*	VL
		Grays/Chinook rivers (WA)	VH	M	H	M
		Big Creek (OR)	*	*	*	VL
		Elochoman/Skamakowa rivers (WA)	VL	H	L	VL
		Clatskanie River (OR)	*	*	*	VL
		Mill, Abernathy and Germany creeks (WA)	VL	H	L	VL
		Scappoose Creek (OR)	*	*	*	VL

Table 22 (continued) – CR chum salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2012a). Persistence probability ratings are very low (VL), low (L), moderate (M), high (H), to very high (VH).

Cascade Range	Summer	Cowlitz River (WA)	VL	L	L	VL
	Fall	Cowlitz River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		Lewis River (WA)	VL	H	L	VL
		Salmon Creek (WA)	VL	L	L	VL
		Clackamas River (OR)	*	*	*	VL
		Sandy River (OR)	*	*	*	
		Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Fall	Lower Gorge (WA & OR)	VH	H	VH	H
		Upper Gorge (WA & OR)	VL	L	L	VL

* No data are available to make a quantitative assessment.

The very low persistence probabilities or possible extirpations of most chum salmon populations are due to low abundance, productivity, spatial structure, and diversity. Although, hatchery production of chum salmon has been limited and hatchery effects on diversity are thought to have been relatively small, diversity has been greatly reduced at the ESU level because of presumed extirpations and the low abundance in the remaining populations (fewer than 100 spawners per year for most populations)(Lower Columbia Fish Recovery Board 2010; NMFS 2012a). The Lower Gorge population meets abundance and productivity criteria for very high levels of viability, but the distribution of spawning habitat (i.e., , spatial structure) for the population has been significantly reduced (Lower Columbia Fish Recovery Board 2010); spatial structure may need to be improved, at least in part, through better performance from the Oregon portion of the population (NMFS 2012a).

<u>Abundance and Productivity</u>. Of the 17 populations that historically made up this ESU, 15 of them (six in Oregon and nine in Washington) are so depleted that either their baseline probability of persistence is very low or they are extirpated or nearly so (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2012a; ODFW 2010). All three strata in the ESU fall significantly short of the WLC-TRT criteria for viability. Currently almost all natural production occurs in just two populations: the Grays/Chinook and the Lower Gorge. The Grays/Chinook population has a moderate persistence probability, and the Lower Gorge population has a high probability of persistence (Lower Columbia Fish Recovery Board 2010; NMFS 2012a).

<u>Limiting factors</u> include (NMFS 2012a; NOAA Fisheries 2011):

- Degraded estuarine and nearshore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system

- Degraded freshwater habitat, in particular of floodplain connectivity and function, channel structure and complexity, stream substrate, and riparian areas and large wood recruitment as a result of cumulative impacts of agriculture, forestry, and development
- Degraded stream flow as a result of hydropower and water supply operations
- Loss of access and loss of some habitat types as a result of passage barriers such as roads and railroads
- Reduced water quality
- Current or potential predation from hatchery-origin salmonids, including coho salmon
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

d. ***Status of LCR Coho Salmon* –** Spatial Structure and Diversity. This species includes all naturally-spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood rivers; in the Willamette River to Willamette Falls, Oregon; and progeny of 25 artificial propagation programs.[6] Spatial diversity is rated "moderate" to "very high" for all the populations, except the North Fork Lewis River, which has a "low" rating for spatial structure.

Three status evaluations of LCR coho salmon status, all based on WLC-TRT criteria, have been conducted since the last NMFS status review in 2005 (McElhany et al. 2007; NMFS 2012a). Out of the 24 populations that make up this ESU (Table 23), 21 are considered to have a very low probability of persisting for the next 100 years, and none is considered viable (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2012a; ODFW 2010).

[6] The Elochoman Hatchery Type-S and Type-N coho salmon programs were eliminated in 2008. The last adults from these two programs returned to the Elochoman in 2010. NMFS has recommended that these two programs be removed from the ESU (NMFS 2011a).

Table 23 – LCR coho salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2012a). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Ecological Subregions	Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Coast Range	Young's Bay (OR)	VL	VH	VL	VL
	Grays/Chinook rivers (WA)	VL	H	VL	VL
	Big Creek (OR)	VL	H	L	VL
	Elochoman/Skamokawa creeks (WA)	VL	H	VL	VL
	Clatskanie River (OR)	L	VH	M	L
	Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
	Scappoose River (OR)	M	H	M	M
Cascade Range	Lower Cowlitz River (WA)	VL	M	M	VL
	Upper Cowlitz River (WA)	VL	M	L	VL
	Cispus River (WA)	VL	M	L	VL
	Tilton River (WA)	VL	M	L	VL
	South Fork Toutle River (WA)	VL	H	M	VL
	North Fork Toutle River (WA)	VL	M	L	VL
	Coweeman River (WA)	VL	H	M	VL
	Kalama River (WA)	VL	H	L	VL
	North Fork Lewis River (WA)	VL	L	L	VL
	East Fork Lewis River (WA)	VL	H	M	VL
	Salmon Creek (WA)	VL	M	VL	VL
	Clackamas River (OR)	M	VH	H	M
	Sandy River (OR)	VL	H	M	VL
	Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Lower Gorge Tributaries (WA & OR)	VL	M	VL	VL
	Upper Gorge/White Salmon (WA)	VL	M	VL	VL
	Upper Gorge Tributaries/Hood (OR)	VL	VH	L	VL

Abundance and Productivity. In Oregon, the Clatskanie Creek and Clackamas River populations have "low" and "moderate" persistence probability ratings for A&P, while the rest are rated "very low." All of the Washington populations have "very low" A&P ratings. The persistence probability for diversity is "high" in the Clackamas population, "moderate" in the Clatskanie, Scappoose, Lower Cowlitz, South Fork Toutle, Coweeman, East Fork Lewis, and Sandy populations, and "low" to "very low" in the rest (NMFS 2012a). Uncertainty is high because of a lack of adult spawner surveys. Smolt traps indicate some natural production in Washington populations, though given the high fraction of hatchery origin spawners suspected to occur in these populations it is not clear that any are self-sustaining. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011; NMFS 2011a; NMFS 2012a).

Limiting Factors include (NMFS 2012a; NOAA Fisheries 2011):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Fish passage barriers that limit access to spawning and rearing habitats
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Hatchery-related effects
- Harvest-related effects
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

***e. Status of LCR Steelhead* –** Spatial Structure and Diversity. Four strata and 23 historical populations of LCR steelhead occur within the DPS: 17 winter-run populations and six summer-run populations, within the Cascade and Gorge ecological subregions (Table 24).[7] The DPS also includes the progeny of ten artificial propagation programs.[8] Summer steelhead return to freshwater long before spawning. Winter steelhead, in contrast, return from the ocean much closer to maturity and spawn within a few weeks. Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. Where no temporal barriers exist, the winter-run life history dominates.

[7] The White Salmon and Little White Salmon steelhead populations are part of the Middle Columbia steelhead DPS and are addressed in a separate species-level recovery plan, the Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan (NMFS 2009b).

[8] In 2007, the release of Cowlitz Hatchery winter steelhead into the Tilton River was discontinued; in 2009, the Hood River winter steelhead program was discontinued; and in 2010, the release of hatchery winter steelhead into the Upper Cowlitz and Cispus rivers was discontinued. In 2011, NMFS recommended removing these programs from the DPS. A Lewis River winter steelhead program was initiated in 2009, and in 2011, NMFS proposed that it be included in the DPS (NMFS 2011a).

Table 24 – LCR steelhead strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2012a). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum: Ecological Subregion	Stratum: Run Timing	Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Cascade Range	Summer	Kalama River (WA)	H	VH	M	M
		North Fork Lewis River (WA)	VL	VL	VL	VL
		East Fork Lewis River (WA)	VL	VH	M	VL
		Washougal River (WA)	M	VH	M	M
	Winter	Lower Cowlitz River (WA)	L	M	M	L
		Upper Cowlitz River (WA)	VL	M	M	VL
		Cispus River (WA)	VL	M	M	VL
		Tilton river (WA)	VL	M	M	VL
		South Fork Toutle River (WA)	M	VH	H	M
		North Fork Toutle River (WA)	VL	H	H	VL
		Coweeman River (WA)	L	VH	VH	L
		Kalama River (WA)	L	VH	H	L
		North Fork Lewis River (WA)	VL	M	M	VL
		East Fork Lewis River (WA)	M	VH	M	M
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	M	VH	M	M
		Sandy River (OR)	L	M	M	L
		Washougal River (WA)	L	VH	M	L
Columbia Gorge	Summer	Wind River (WA)	VH	VH	H	H
		Hood River (OR)	VL	VH	L	VL
	Winter	Lower Gorge (WA & OR)	L	VH	M	L
		Upper Gorge (OR & WA)	L	M	M	L
		Hood River (OR)	M	VH	M	M

It is likely that genetic and life history diversity has been reduced as a result of pervasive hatchery effects and population bottlenecks. Spatial structure remains relatively high for most populations Out of the 23 populations, 16 are considered to have a “low” or “very low” probability of persisting over the next 100 years, and six populations have a “moderate” probability of persistence (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2012a; ODFW 2010). All four strata in the DPS fall short of the WLC-TRT criteria for viability (NMFS 2012a).

Baseline persistence probabilities were estimated to be “low” or “very low” for three out of the six summer steelhead populations that are part of the LCR DPS, moderate for two, and high for one—the Wind, which is considered viable (Lower Columbia Fish Recovery Board 2010; NMFS 2012a; ODFW 2010). Thirteen of the 17 LCR winter steelhead populations have “low” or “very low” baseline probabilities of persistence, and the remaining four are at “moderate” probability of persistence (Table 13) (Lower Columbia Fish Recovery Board 2010; NMFS 2012a; ODFW 2010).

Abundance and Productivity. The “low” to “very low” baseline persistence probabilities of most Lower Columbia River steelhead populations reflects low abundance and productivity (NMFS 2012a). All of the populations increased in abundance during the early 2000s, generally peaking in 2004. Most populations have since declined back to levels within one standard deviation of the long term mean. Exceptions are the Washougal summer-run and North Fork Toutle winter-run, which are still higher than the long term average, and the Sandy, which is lower. In general, the populations do not show any sustained dramatic changes in abundance or fraction of hatchery origin spawners since the 2005 status review (Ford 2011). Although current LCR steelhead populations are depressed compared to historical levels and long-term trends show declines, many populations are substantially healthier than their salmon counterparts, typically because of better habitat conditions in core steelhead production areas (Lower Columbia Fish Recovery Board 2010; NMFS 2012a).

Limiting Factors include (NMFS 2012a; NOAA Fisheries 2011):

- Degraded estuarine and nearshore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and recruitment of large wood, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects and lowland development
- Avian and marine mammal predation in the lower mainstem Columbia River and estuary.
- Hatchery-related effects
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

f. ***Status of UWR Steelhead –*** Spatial Structure and Diversity. This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River. One stratum and four extant populations of UWR steelhead occur within the DPS

(Table 25). Historical observations, hatchery records, and genetics suggest that the presence of UWR steelhead in many tributaries on the west side of the upper basin is the result of recent introductions. Nevertheless, the WLC-TRT recognized that although west side UWR steelhead does not represent a historical population, those tributaries may provide juvenile rearing habitat or may be temporarily (for one or more generations) colonized during periods of high abundance. Hatchery summer-run steelhead that are released in the subbasins are from an out-of-basin stock, not part of the DPS. Additionally, stocked summer steelhead that have become established in the McKenzie River were not considered in the identification of historical populations (ODFW and NMFS 2011).

Table 25 – Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR steelhead (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk
Molalla River	VL	M	M	L
North Santiam River	VL	M	H	L
South Santiam River	VL	M	M	L
Calapooia River	M	M	VH	M

Abundance and Productivity. Since the last status review in 2005, UWR steelhead initially increased in abundance but subsequently declines and current abundance is at the levels observed in the mid-1990s when the DPS was first listed. The DPS appears to be at lower risk than the UWR Chinook salmon ESU, but continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood recruitment, and stream flow have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Reduced access to spawning and rearing habitats mainly as a result of

artificial barriers in spawning tributaries

- Hatchery-related effects: impacts from the non-native summer steelhead hatchery program
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation and competition on native UWR steelhead.

g. ***Status of Southern DPS Green Sturgeon*** **–** Refer to status discussion under the Puget Sound Recovery Domain.

h. ***Status of Southern DPS Eulachon*** **–** Refer to status discussion under the Puget Sound Recovery Domain.

3. **Interior Columbia Recovery Domain.** Species in the Interior Columbia (IC) recovery domain include UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, UCR steelhead, MCR steelhead, and SRB steelhead. The IC-TRT identified 82 populations of those species based on genetic, geographic (hydrographic), and habitat characteristics (Table 26). In some cases, the IC-TRT further aggregated populations into "major groupings" based on dispersal distance and rate, and drainage structure, primarily the location and distribution of large tributaries (IC-TRT 2003). All 82 populations identified use the lower mainstem of the Snake River, the mainstem of the Columbia River, and the Columbia River estuary, or part thereof, for migration, rearing, and smoltification.

Table 26 – Populations of ESA-listed salmon and steelhead in the IC recovery domain.

Species	Populations
UCR spring-run Chinook salmon	3
SR spring/summer-run Chinook salmon	28
SR fall-run Chinook salmon	1
SR sockeye salmon	1
MCR steelhead	17
UCR steelhead	4
SRB steelhead	24

The IC-TRT also recommended viability criteria that follow the VSP framework (McElhany et al. 2006) and described biological or physical performance conditions that, when met, indicate a population or species has a 5% or less risk of extinction over a 100-year period (IC-TRT 2007).

a. ***Status of UCR Spring-run Chinook Salmon*** **–** Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River), the Columbia River upstream to Chief Joseph Dam, and progeny of six artificial propagation programs. The IC-TRT identified four independent populations of UCR spring-run Chinook salmon in the upriver tributaries of Wenatchee, Entiat, Methow, and Okanogan (extirpated), but no major groups due to the relatively small geographic area affected (Ford 2011; IC-TRT 2003)(Table 27).

Table 27 – Scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for spring-run UCR Chinook salmon (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).

Population	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River				E

The composite SS/D risks for all three of the extant populations in this MPG are at "high" risk. The spatial processes component of the SS/D risk is "low" for the Wenatchee River and Methow River populations and "moderate" for the Entiat River (loss of production in lower section increases effective distance to other populations). All three of the extant populations in this MPG are at "high" risk for diversity, driven primarily by chronically high proportions of hatchery-origin spawners in natural spawning areas and lack of genetic diversity among the natural-origin spawners (Ford 2011).

Increases in natural origin abundance relative to the extremely low spawning levels observed in the mid-1990s are encouraging; however, average productivity levels remain extremely low. Overall, the viability of Upper Columbia Spring Chinook salmon ESU has likely improved somewhat since the last status review, but the ESU is still clearly at "moderate-to-high" risk of extinction (Ford 2011).

<u>Abundance and Productivity</u>. UCR spring-run Chinook salmon is not currently meeting the viability criteria (adapted from the IC-TRT) in the Upper Columbia Recovery Plan. A&P remains at "high" risk for each of the three extant populations in this MPG/ESU (Table 16). The 10-year geometric mean abundance of adult natural origin spawners has increased for each population relative to the levels for the 1981-2003 series, but the estimates remain below the corresponding IC-TRT thresholds. Estimated productivity (spawner to spawner return rate at low to moderate escapements) was on average lower over the years 1987-2009 than for the previous period. The combinations of current abundance and productivity for each population result in a "high" risk rating.

Limiting Factors include (NOAA Fisheries 2011; UCSRB 2007):

- Mainstem Columbia River hydropower–related adverse effects: upstream and downstream fish passage, ecosystem structure and function, flows, and water quality
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Degraded estuarine and nearshore marine habitat
- Hatchery related effects: including past introductions and persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species
- Harvest in Columbia River fisheries

b. ***Status of SR Spring/summer-run Chinook Salmon*** **–** Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins; and progeny of fifteen artificial propagation programs. The IC-TRT identified 28 extant and 4 extirpated populations of SR spring/summer-run Chinook salmon, and aggregated these into major population groups(Ford 2011; IC-TRT 2003). Each of these populations faces a "high" risk of extinction (Ford 2011) (Table 28).

Table 28 – SR spring/summer-run Chinook salmon ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SR spring/summer-run Chinook salmon (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).

Ecological Subregions	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Lower Snake River	Tucannon River	H	M	M	H
	Asotin River				E
Grande Ronde and Imnaha rivers	Wenaha River	H	M	M	H
	Lostine/Wallowa River	H	M	M	H
	Minam River	H	M	M	H
	Catherine Creek	H	M	M	H
	Upper Grande Ronde R.	H	M	H	H
	Imnaha River	H	M	M	H
	Big Sheep Creek				E
	Lookingglass Creek				E
South Fork Salmon River	Little Salmon River	*	*	*	H
	South Fork mainstem	H	M	M	H
	Secesh River	H	L	L	H
	EF/Johnson Creek	H	L	L	H

Table 28 (continued) – SR spring/summer-run Chinook salmon ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SR spring/summer-run Chinook salmon (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E).

Middle Fork Salmon River	Chamberlin Creek	H	L	L	H
	Big Creek	H	M	M	H
	Lower MF Salmon	H	M	M	H
	Camas Creek	H	M	M	H
	Loon Creek	H	M	M	H
	Upper MF Salmon	H	M	M	H
	Pistol Creek				E
	Sulphur Creek	H	M	M	H
	Bear Valley Creek	H	L	L	H
	Marsh Creek	H	L	L	H
Upper Mainstem Salmon	N. Fork Salmon River	H	L	L	H
	Lemhi River	H	H	H	H
	Pahsimeroi River	H	H	H	H
	Upper Salmon-lower mainstem	H	L	L	H
	East Fork Salmon River	H	H	H	H
	Yankee Fork	H	H	H	H
	Valley Creek	H	M	M	H
	Upper Salmon main	H	M	M	H
	Panther Creek				E

* Insufficient data.

Abundance and Productivity. Population level status ratings remain at "high" risk across all MPGs within the ESU, although recent natural spawning abundance estimates have increased, all populations remain below minimum natural origin abundance thresholds (Table 17). Spawning escapements in the most recent years in each series are generally well below the peak returns but above the extreme low levels in the mid-1990s. Relatively low natural production rates and spawning levels below minimum abundance thresholds remain a major concern across the ESU.

The ability of SR spring/summer-run Chinook salmon populations to be self-sustaining through normal periods of relatively low ocean survival remains uncertain. Factors cited by Good (2005) remain as concerns or key uncertainties for several populations. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, elevated water temperature, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development

- Mainstem Columbia River and Snake River hydropower impacts
- Harvest-related effects
- Predation

c. ***Status of SR Fall-run Chinook Salmon –*** Spatial Structure and Diversity**.** This species includes all naturally-spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River, and progeny of four artificial propagation programs. The IC-TRT identified three populations of this species, although only the lower mainstem population exists at present, and it spawns in the lower main stem of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers. The extant population of Snake River fall-run Chinook salmon is the only remaining population from an historical ESU that also included large mainstem populations upstream of the current location of the Hells Canyon Dam complex (Ford 2011; IC-TRT 2003). The population is at moderate risk for diversity and spatial structure. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Abundance and Productivity. The recent increases in natural origin abundance are encouraging. However, hatchery origin spawner proportions have increased dramatically in recent years – on average, 78% of the estimated adult spawners have been hatchery origin over the most recent brood cycle. The apparent leveling off of natural returns in spite of the increases in total brood year spawners may indicate that density dependent habitat effects are influencing production or that high hatchery proportions may be influencing natural production rates. The A&P risk rating for the population is "moderate." Given the combination of current A&P and SS/D ratings summarized above, the overall viability rating for Lower SR fall Chinook salmon would be rated as "maintained."[9]

Limiting Factors include (NOAA Fisheries 2011):

Factor 1. Degraded freshwater habitat: Floodplain connectivity and function, and channel structure and complexity have been degraded as a result of cumulative impacts of agriculture, forestry, and development.

Factor 2. Harvest-related effects

Factor 3. Loss of access to historic habitat above Hells Canyon and other Snake River dams

Factor 4. Mainstem Columbia River and Snake River hydropower impacts

[9] "Maintained" population status is for populations that do not meet the criteria for a viable population but do support ecological functions and preserve options for ESU/DPS recovery.

Factor 5. Hatchery-related effects
Factor 6. Degraded estuarine and nearshore habitat

d. ***Status of SR Sockeye Salmon*** **–** Spatial Structure and Diversity**.** This species includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, and artificially-propagated sockeye salmon from the Redfish Lake captive propagation program. The IC-TRT identified historical sockeye salmon production in at least five Stanley Basin and Sawtooth Valley lakes and in lake systems associated with Snake River tributaries currently cut off to anadromous access (*e.g.,* Wallowa and Payette Lakes), although current returns of SR sockeye salmon are extremely low and limited to Redfish Lake (IC-TRT 2007).

Abundance and Productivity. This species is still at extremely high risk across all four basic risk measures (abundance, productivity, spatial structure and diversity. Although the captive brood program has been successful in providing substantial numbers of hatchery produced *O. nerka* for use in supplementation efforts, substantial increases in survival rates across life history stages must occur to re-establish sustainable natural production (Hebdon et al. 2004; Keefer et al. 2008). Overall, although the risk status of the Snake River sockeye salmon ESU appears to be on an improving trend, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors. The key factor limiting recovery of SR sockeye salmon ESU is survival outside of the Stanley Basin. Portions of the migration corridor in the Salmon River are impeded by water quality and temperature (Idaho Department of Environmental Quality 2011). Increased temperatures likely reduce the survival of adult sockeye returning to the Stanley Basin. The natural hydrological regime in the upper mainstem Salmon River Basin has been altered by water withdrawals. In most years, sockeye adult returns to Lower Granite suffer catastrophic losses (Reed et al. 2003) (e.g., > 50% mortality in one year) before reaching the Stanley Basin, although the factors causing these losses have not been identified. In the Columbia and lower Snake River migration corridor, predation rates on juvenile sockeye salmon are unknown, but terns and cormorants consume 12% of all salmon smolts reaching the estuary, and piscivorous fish consume an estimated 8% of migrating juvenile salmon (NOAA Fisheries 2011).

e. ***Status of MCR Steelhead*** **–** Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and artificial impassable barriers in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding steelhead from the Snake River basin; and progeny of seven artificial propagation programs. The IC-TRT identified 17 extant populations in this DPS (IC-TRT 2003). The populations fall into four major population groups: the Yakima River Basin (four extant populations), the Umatilla/Walla-Walla drainages (three extant and one extirpated populations); the John Day River drainage (five extant populations) and the Eastern Cascades group (five extant and two extirpated populations) (Table 29) (Ford 2011; NMFS 2009b).

Table 29 – Ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for MCR steelhead (NMFS 2009; Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Ecological Subregions	Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Cascade Eastern Slope Tributaries	Fifteenmile Creek	L	L	L	Viable
	Klickitat River	M	M	M	MT?
	Eastside Deschutes River	L	M	M	Viable
	Westside Deschutes River	H	M	M	H*
	Rock Creek	H	M	M	H?
	White Salmon				E*
	Crooked River				E*
John Day River	Upper Mainstem	M	M	M	MT
	North Fork	VL	L	L	Highly Viable
	Middle Fork	M	M	M	MT
	South Fork	M	M	M	MT
	Lower Mainstem	M	M	M	MT
Walla Walla and Umatilla rivers	Umatilla River	M	M	M	MT
	Touchet River	M	M	M	H
	Walla Walla River	M	M	M	MT
Yakima River	Satus Creek	M	M	M	Viable (MT)
	Toppenish Creek	M	M	M	Viable (MT)
	Naches River	H	M	M	H
	Upper Yakima	H	H	H	H

* Re-introduction efforts underway (NMFS 2009).

Straying frequencies into at least the Lower John Day River population are high. Out-of-basin hatchery stray proportions, although reduced, remain very high in the Deschutes River basin.

<u>Abundance and Productivity</u>. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the MCR steelhead DPS is not currently meeting the viability criteria (adopted from the IC-TRT) in the MCR steelhead

recovery plan (NMFS 2009b). In addition, several of the factors cited by Good (2005) remain as concerns or key uncertainties. Natural origin spawning estimates of populations have been highly variable with respect to meeting minimum abundance thresholds. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Limiting Factors include (NMFS 2009b; NOAA Fisheries 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas, fish passage, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, tributary hydro system activities, and development
- Mainstem Columbia River hydropower–related impacts
- Degraded estuarine and nearshore marine habitat
- Hatchery-related effects
- Harvest-related effects
- Effects of predation, competition, and disease

f. ***Status of UCR Steelhead*** **–** Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S.-Canada border, and progeny of six artificial propagation programs. Four independent populations of UCR steelhead were identified by the IC-TRT in the same upriver tributaries as for UC spring-run Chinook salmon (i.e., Wenatchee, Entiat, Methow, and Okanogan; Table 30) and, similarly, no major population groupings were identified due to the relatively small geographic area involved (Ford 2011; IC-TRT 2003). All extant populations are considered to be at high risk of extinction (Table 19) (Ford 2011). With the exception of the Okanogan population, the Upper Columbia populations rated as “low” risk for spatial structure. The “high” risk ratings for SS/D are largely driven by chronic high levels of hatchery spawners within natural spawning areas and lack of genetic diversity among the populations. The proportions of hatchery origin returns in natural spawning areas remain extremely high across the DPS, especially in the Methow and Okanogan River populations. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Table 30 – Summary of the key elements (A&P, diversity, and SS/D) and scores used to determine current overall viability risk for UCR steelhead populations (Ford 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H
Okanogan River	H	H	H	H

Abundance and Productivity. Upper Columbia steelhead populations have increased in natural origin abundance in recent years, but productivity levels remain low. The modest improvements in natural returns in recent years are probably primarily the result of several years of relatively good natural survival in the ocean and tributary habitats.

Limiting Factors include (NOAA Fisheries 2011; UCSRB 2007):

- Mainstem Columbia River hydropower–related adverse effects
- Impaired tributary fish passage
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Effects of predation, competition, and disease mortality: Fish management, including past introductions and persistence of non-native (exotic) fish species continues to affect habitat conditions for listed species.
- Hatchery-related effects
- Harvest-related effects

g. ***Status of SRB Steelhead*** **–** Spatial Structure and Diversity**.** This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, and progeny of six artificial propagation programs. The IC-TRT identified 25 historical populations in five major groups (Table 31) (Ford 2011; IC-TRT 2011). The IC-TRT has not assessed the viability of this species. The relative proportion of hatchery fish in natural spawning areas near major hatchery release sites is highly uncertain. There is little evidence for substantial change in ESU viability relative to the previous BRT and IC-TRT reviews. Overall, therefore, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011).

Table 31 – Ecological subregions, populations, and scores for the key elements (A&P, diversity, and SS/D) used to determine current overall viability risk for SRB steelhead (Ford 2011; NMFS 2011). Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH). Maintained (MT) population status indicates that the population does not meet the criteria for a viable population but does support ecological functions and preserve options for recovery of the DPS.

Ecological subregions	Spawning Populations (Watershed)	A&P	Diversity	Integrated SS/D	Overall Viability Risk*
Lower Snake River	Tucannon River	**	M	M	H
	Asotin Creek	**	M	M	MT
Grande Ronde River	Lower Grande Ronde	**	M	M	Not rated
	Joseph Creek	VL	L	L	Highly viable
	Upper Grande Ronde	M	M	M	MT
	Wallowa River	**	L	L	H
Clearwater River	Lower Clearwater	M	L	L	MT
	South Fork Clearwater	H	M	M	H
	Lolo Creek	H	M	M	H
	Selway River	H	L	L	H
	Lochsa River	H	L	L	H
Salmon River	Little Salmon River	**	M	M	MT
	South Fork Salmon	**	L	L	H
	Secesh River	**	L	L	H
	Chamberlain Creek	**	L	L	H
	Lower MF Salmon	**	L	L	H
	Upper MF Salmon	**	L	L	H
	Panther Creek	**	M	H	H
	North Fork Salmon	**	M	M	MT
	Lemhi River	**	M	M	MT
	Pahsimeroi River	**	M	M	MT
	East Fork Salmon	**	M	M	MT
	Upper Main Salmon	**	M	M	MT
Imnaha	Imnaha River	M		M	MT

* There is uncertainty in these ratings due to a lack of population-specific data.
** Insufficient data.

Abundance and Productivity. The level of natural production in the two populations with full data series and the Asotin Creek index reaches is encouraging, but the status of most populations in this DPS remains highly uncertain. Population-level natural origin abundance and productivity inferred from aggregate data and juvenile indices indicate that many populations are likely below the minimum combinations defined by the IC-TRT viability criteria.

Limiting Factors include (IC-TRT 2011; NMFS 2011b):

- Mainstem Columbia River hydropower–related adverse effects
- Impaired tributary fish passage

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Impaired water quality and increased water temperature
- Related harvest effects, particularly for B-run steelhead
- Predation
- Genetic diversity effects from out-of-population hatchery releases

4. **Oregon Coast Recovery Domain.** The OC recovery domain includes OC coho salmon, southern green sturgeon, and eulachon, covering Oregon coastal streams south of the Columbia River and north of Cape Blanco. Streams and rivers in this area drain west into the Pacific Ocean, and vary in length from less than a mile to more than 210 miles in length.

   a. Status of OC Coho Salmon – Spatial Structure and Diversity**.** This species includes populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco. The Cow Creek stock (South Umpqua population) is included as part of the ESU because the original brood stock was founded from the local, natural origin population and natural origin coho salmon have been incorporated into the brood stock on a regular basis.

   The OC-TRT identified 56 populations; 21 independent and 35 dependent. The dependent populations were dependent on strays from other populations to maintain them over long time periods. The TRT also identified 5 biogeographic strata (Table 32) (Lawson et al. 2007).

Table 32 – OC coho salmon populations. Dependent populations (D) are populations that historically would not have had a high likelihood of persisting in isolation for 100 years. These populations relied upon periodic immigration from other populations to maintain their abundance. Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years and are rated as functionally independent (FI) and potentially independent (PI) (McElhany et al. 2000, Lawson et al. 2007).

Stratum	Population	Type	Stratum	Population	Type
North Coast	Necanicum River	PI	Mid-Coast (cont.)	Alsea River	FI
	Ecola Creek	D		Big Creek (Alsea)	D
	Arch Cape Creek	D		Vingie Creek	D
	Short Sands Creek	D		Yachats River	D
	Nehalem River	FI		Cummins Creek	D
	Spring Creek	D		Bob Creek	D
	Watseco Creek	D		Tenmile Creek	D
	Tillamook Bay	FI		Rock Creek	D
	Netarts Bay	D		Big Creek (Siuslaw)	D
	Rover Creek	D		China Creek	D
	Sand Creek	D		Cape Creek	D
	Nestucca River	FI		Berry Creek	D
	Neskowin Creek	D		Sutton Creek	D
Mid-Coast	Salmon River	PI	Lakes	Siuslaw River	FI
	Devils Lake	D		Siltcoos Lake	PI
	Siletz River	FI		Tahkenitch Lake	PI
	Schoolhouse Creek	D		Tenmile Lakes	PI
	Fogarty Creek	D	Umpqua	Lower Umpqua River	FI
	Depoe Bay	D		Middle Umpqua River	FI
	Rocky Creek	D		North Umpqua River	FI
	Spencer Creek	D		South Umpqua River	FI
	Wade Creek	D	Mid-South Coast	Threemile Creek	D
	Coal Creek	D		Coos River	FI
	Moolack Creek	D		Coquille River	FI
	Big Creek (Yaquina)	D		Johnson Creek	D
	Yaquina River	FI		Twomile Creek	D
	Theil Creek	D		Floras Creek	PI
	Beaver Creek	PI		Sixes River	PI

A 2010 BRT noted significant improvements in hatchery and harvest practices have been made (Stout et al. 2011). However, harvest and hatchery reductions have changed the population dynamics of the ESU. Current concerns for spatial structure focus on the Umpqua River. Of the four populations in the Umpqua stratum, the North Umpqua and South Umpqua were of particular concern. The North Umpqua is controlled by Winchester Dam and has historically been dominated by hatchery fish. Hatchery influence has recently been reduced, but the natural productivity of this population remains to be demonstrated. The South Umpqua is a large, warm system with degraded habitat. Spawner distribution appears to be seriously restricted in this population, and it is probably the most vulnerable of any population in this ESU to increased temperatures.

Current status of diversity shows improvement through the waning effects of hatchery fish on populations of OC coho salmon. In addition, recent efforts in several coastal estuaries to restore lost wetlands should be beneficial. However, diversity is lower than it was historically because of the loss of both freshwater and tidal habitat loss coupled with the restriction of diversity from very low returns over the past 20 years.

Abundance and Productivity. It has not been demonstrated that productivity during periods of poor marine survival is now adequate to sustain the ESU. Recent increases in adult escapement do not provide strong evidence that the century-long downward trend has changed. The ability of the OC coho salmon ESU to survive another prolonged period of poor marine survival remains in question. Wainwright (2008) determined that the weakest strata of OC coho salmon were in the North Coast and Mid-Coast of Oregon, which had only "low" certainty of being persistent. The strongest strata were the Lakes and Mid-South Coast, which had "high" certainty of being persistent. To increase certainty that the ESU as a whole is persistent, they recommended that restoration work should focus on those populations with low persistence, particularly those in the North Coast, Mid-Coast, and Umpqua strata.

Limiting Factors include (NOAA Fisheries 2011; Stout et al. 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, instream mining, dams, road crossings, dikes, levees, etc.
- Fish passage barriers that limit access to spawning and rearing habitats
- Adverse climate, altered past ocean/marine productivity, and current ocean ecosystem conditions have favored competitors and predators and reduced salmon survival rates in freshwater rivers and lakes, estuaries, and marine environments

b. ***Status of Southern DPS Green Sturgeon* –** Refer to status discussion under the Puget Sound Recovery Domain.

c. ***Status of Southern DPS Eulachon* –** Refer to status discussion under the Puget Sound Recovery Domain.

5. **<u>Southern Oregon and Northern California Coasts Recovery Domain</u>.** The SONCC recovery domain includes coho salmon, southern green sturgeon, and eulachon. The SONCC recovery domain extends from Cape Blanco, Oregon, to Punta Gorda, California. This area includes many small-to-moderate-sized coastal basins, where high quality habitat occurs in the lower reaches of each basin, and three large basins (Rogue, Klamath and Eel) where high quality habitat is in the lower reaches, little habitat is provided by the middle reaches, and the largest amount of habitat is in the upper reaches.

    a. ***Status of SONCC Coho Salmon*** **–** <u>Spatial Structure and Diversity</u>**.** This species includes all naturally-spawned populations of coho salmon in coastal streams from the Elk River near Cape Blanco, Oregon, through and including the Mattole River near Punta Gorda, California, and progeny of three artificial propagation programs (NMFS 2012b). Williams et al. (2006) designated 45 populations of coho salmon in the SONCC coho salmon ESU. These populations were further grouped into seven diversity strata based on the geographical arrangement of the populations and basin-scale genetic, environmental, and ecological characteristics (Table 33).

Table 33 – SONCC coho salmon populations in Oregon. Williams et al. (2006) classified populations as dependent or independent based on their historic population size. Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years and are rated as functionally independent (FI) and potentially independent (PI). Core population types are independent populations judged most likely to become viable most quickly. Non-core 1 population types are independent populations judged to have lesser potential for rapid recovery than the core populations. Dependent populations (D) are populations that historically would not have had a high likelihood of persisting in isolation for 100 years. These populations relied upon periodic immigration from other populations to maintain their abundance. Two ephemeral populations (E) are defined as populations both small enough and isolated enough that they are only intermittently present (McElhany et al. 2000; Williams et al. 2006; NMFS 2012b).

Stratum	Population	Population Type
Northern Coastal	Elk River	FI Core
	Hubbard Creek	E
	Brush Creek	D
	Mussel Creek	D
	Euchre Creek	E
	Lower Rogue River	PI Non-Core 1
	Hunter Creek	D
	Pistol River	D
	Chetco River	FI Core
	Winchuck River*	PI Non-Core 1
Interior Rogue	Upper Rogue River	FI Core
	Middle Rogue/Applegate*	FI Non-Core 1
	Illinois River*	FI Core
Interior Klamath	Upper Klamath River*	FI Core
Central Coastal	Smith River*	FI core

* Populations that also occur partly in California.

NMFS considered the role each population is expected to play in a recovered ESU to determine population abundance and juvenile occupancy targets for all the populations in the SONCC coho salmon ESU. Independent populations are evaluated using a modified Bradbury et. al (1995) framework. This model uses three groupings of criteria for ranking watersheds for Pacific salmon restoration prioritization: 1) biological and ecological resources (Biological Importance); 2) watershed integrity and salmonid extinction risk (Integrity and Risk); and 3) potential for restoration (Optimism and Potential). Scores for Biological Importance are based on the concept of VSPs (McElhany et al. 2000), and are used to describe the current status of the population – population size, productivity, spatial structure, and diversity. "Core" populations were designated based on current condition, geographic location in the ESU, low risk threshold compared to the number of spawners needed

for the entire stratum, and other factors. “Non-core 1” populations are in the moderate risk threshold, which is the depensation threshold10 multiplied by four. NMFS chooses this target if the population is likely to ultimately produce considerably more than the depensation threshold, but less than the low risk threshold.
The draft recovery plan establishes the following criteria at the ESU, diversity strata, and population scales to measure whether the recovery objectives are met (NMFS 2012b). Refer to Table 34.

Table 34 – Recovery Objectives

VSP Parameter	Population Type	Recovery Objective	Recovery Criteria
Abundance	Core	Low risk of extinction.	The geometric mean of wild spawners over 12 years at least meets the “low risk threshold” of spawners for each core population
	Non-Core 1	Moderate or low risk of extinction.	The annual number of wild spawners meets or exceeds the moderate risk threshold for each non-core population
Productivity	Core and Non-Core 1	Population growth rate is not negative.	Slope of regression of the geometric mean of wild spawners over the time series ≥ zero
Spatial Structure	Core and Non-Core 1	Ensure populations are widely distributed.	Annual within-population distribution ≥ 80% of habitat (outside of a temperature mask)
	Non-Core 2 and Dependent	Achieve inter- and intra-stratum connectivity.	20% of accessible habitat is occupied in years following spawning of cohorts that experienced good marine survival
Diversity	Core and Non-Core 1	Achieve low or moderate hatchery impacts on wild fish.	Proportion of hatchery-origin spawners (pHOS) ≤ 0.10
	Core and Non-Core 1	Achieve life history diversity.	Variation is present in migration timing, age structure, size and behavior. Variation in these parameters is retained.

Abundance and Productivity. Although long-term data on abundance of SONCC coho salmon are scarce, available evidence from shorter-term research and monitoring efforts indicate that conditions have worsened for populations since the last formal status review was published (Good *et al.* 2005; NMFS 2012b). Because the extinction risk of an ESU depends upon the

[10] Williams (2008) defines the depensation threshold as one spawner per km of stream with estimated rearing potential or Intrinsic Potential.

extinction risk of its constituent independent populations and the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable (NMFS 2012b).

Limiting Factors. Threats from natural or man-made factors have worsened in the past 5 years, primarily due to four factors: small population dynamics, climate change, multi-year drought, and poor ocean survival conditions (NMFS 2012b; NOAA Fisheries 2011). Limiting factors include:

- Lack of floodplain and channel structure
- Impaired water quality
- Altered hydrologic function (timing of volume of water flow)
- Impaired estuary/mainstem function
- Degraded riparian forest conditions
- Altered sediment supply
- Increased disease/predation/competition
- Barriers to migration
- Adverse fishery-related effects
- Adverse hatchery-related effects

b. ***Status of Southern DPS Green Sturgeon*** **–** Refer to status discussion under the Puget Sound Recovery Domain.

c. ***Status of Southern DPS Eulachon*** **–** Refer to status discussion under the Puget Sound Recovery Domain.

5. **Status of the Critical Habitats –** We reviewed the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated area. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging).

   For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[11] The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the

[11] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005a).

significance to the species of the population occupying that area (NOAA Fisheries 2005a). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (*e.g.,* a population at the extreme end of geographic distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

This section examines critical habitat condition for LCR Chinook salmon, UWR spring-run Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR, steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, OC coho salmon, and SONCC coho salmon, green sturgeon, and eulachon in the WLC, IC, OC and SONCC recovery domains.

The physical or biological features of freshwater spawning and incubation sites, include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 35-36). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

Table 35 – PCEs of critical habitats designated for ESA-listed salmon and steelhead species considered in the opinion (except SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, and SONCC coho salmon), and corresponding species life history events.

Primary Constituent Elements		**Species Life History Event**
Site Type	**Site Attribute**	
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine areas	Forage Water quality	Adult growth and sexual maturation Adult spawning migration Subadult rearing

Table 36 – PCEs of critical habitats designated for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon, SONCC coho salmon, and corresponding species life history events.

Primary Constituent Elements		Species Life History Event
Site	**Site Attribute**	
Spawning and juvenile rearing areas	Access (sockeye) Cover/shelter Food (juvenile rearing) Riparian vegetation Space (Chinook, coho) Spawning gravel Water quality Water temp (sockeye) Water quantity	Adult spawning Embryo incubation Alevin growth and development Fry emergence from gravel Fry/paar/smolt growth and development
Adult and juvenile migration corridors	Cover/shelter Food (juvenile) Riparian vegetation Safe passage Space Substrate Water quality Water quantity Water temperature Water velocity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Areas for growth and development to adulthood	Ocean areas – not identified	Nearshore juvenile rearing Subadult rearing Adult growth and sexual maturation Adult spawning migration

6. **<u>CHART Salmon and Steelhead Critical Habitat Assessments</u>.** The CHART for each recovery domain assessed biological information pertaining to areas under consideration for designation as critical habitat to identify the areas occupied by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PCEs in each HUC_5 watershed for: Quantity; Quality – Current Condition; Quality – Potential Condition; Support of Rarity Importance; Support of Abundant Populations; and Support of Spawning/Rearing.

   Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality – current condition), which considers the existing condition of the quality of PCEs in the HUC_5 watershed; and Factor 3 (quality – potential condition), which considers the likelihood of achieving PCE potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

a. **<u>Southern DPS Green Sturgeon</u>.** A team similar to the CHARTs, referred to as a Critical Habitat Review Team (CHRT), identified and analyzed the conservation value of particular areas occupied by southern green sturgeon, and unoccupied areas they felt are necessary to ensure the conservation of the species. The CHRT did not identify those particular areas using hydrologic unit code (HUC) nomenclature, but did provide geographic place names for those areas, including the names of freshwater rivers, the bypasses, the Sacramento-San Joaquin Delta, coastal bays and estuaries, and coastal marine areas (within 110 m depth) extending from the California/Mexico border north to Monterey Bay, California, and from the Alaska/Canada border northwest to the Bering Strait; and certain coastal bays and estuaries in California, Oregon, and Washington.

For freshwater rivers north of and including the Eel River, the areas upstream of the head of the tide were not considered part of the geographical area occupied by the southern DPS. However, the critical habitat designation recognizes not only the importance of natal habitats, but of habitats throughout their range. Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; the lower Columbia River estuary; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) and freshwater. Table 37 below delineates PCEs for Southern DPS green sturgeon.

Table 37 – PCEs of critical habitat designated for southern green sturgeon and corresponding species life history events.

Primary Constituent Elements		**Species Life History Event**
Site Type	**Site Attribute**	
Freshwater riverine system	Food resources Migratory corridor Sediment quality Substrate type or size Water depth Water flow Water quality	Adult spawning Embryo incubation, growth and development Larval emergence, growth and development Juvenile metamorphosis, growth and development
Estuarine areas	Food resources Migratory corridor Sediment quality Water flow Water depth Water quality	Juvenile growth, development, seaward migration Subadult growth, development, seasonal holding, and movement between estuarine and marine areas Adult growth, development, seasonal holding, movements between estuarine and marine areas, upstream spawning movement, and seaward post-spawning movement
Coastal marine areas	Food resources Migratory corridor Water quality	Subadult growth and development, movement between estuarine and marine areas, and migration between marine areas Adult sexual maturation, growth and development, movements between estuarine and marine areas, migration between marine areas, and spawning migration

The CHRT identified several activities that threaten the PCEs in coastal bays and estuaries and necessitate the need for special management considerations or protection. The application of pesticides is likely to adversely affect prey resources and water quality within the bays and estuaries, as well as the growth and reproductive health of Southern DPS green sturgeon through bioaccumulation. Other activities of concern include those that disturb bottom substrates, adversely affect prey resources, or degrade water quality through re-suspension of contaminated sediments. Of particular concern are activities that affect prey resources. Prey resources are affected by: commercial shipping and activities generating point source pollution and non-point source pollution that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom (but result in beneficial or adverse effects on prey resources for green sturgeon). In addition, petroleum spills from commercial shipping activities and proposed alternative energy hydrokinetic projects are likely to affect water quality or hinder the migration of green sturgeon along the coast.

b. **Southern DPS Eulachon.** Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington (USDC 2011). All of these areas are designated as migration and spawning habitat for this species. In Oregon, 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek have been designated. The mainstem Columbia River from the mouth to the base of Bonneville

Dam, a distance of 143.2 miles is also designated as critical habitat. Table 38 delineates the designated physical or biological features for eulachon.

Table 38 – Physical or biological features of critical habitats designated for eulachon and corresponding species life history events.

Physical or biological features		Species Life History Event
Site Type	**Site Attribute**	
Freshwater spawning and incubation	Flow Water quality Water temperature Substrate	Adult spawning Incubation
Freshwater migration	Flow Water quality Water temperature Food	Adult and larval mobility Larval feeding

The range of eulachon in the Pacific Northwest completely overlaps with the range of several ESA-listed stocks of salmon and steelhead as well as green sturgeon. Although the habitat requirements of these fishes differ somewhat from eulachon, efforts to protect habitat generally focus on the maintenance of watershed processes that would be expected to benefit eulachon. The BRT identified dams and water diversions as moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath systems, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods (Gustafson et al. 2010). Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown (Gustafson et al. 2010). The BRT identified dredging as a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.

The lower Columbia River mainstem provides spawning and incubation sites, and a large migratory corridor to spawning areas in the tributaries. Prior to the construction of Bonneville Dam, eulachon ascended the Columbia River as far as Hood River, Oregon. Major tributaries that support spawning runs include the Grays, Skamokawa, Elochoman, Kalama, Lewis and Sandy rivers.

The number of eulachon returning to the Umpqua River seems to have declined in the 1980s, and does not appear to have rebounded to previous levels. Additionally, eulachon are regularly caught in salmonid smolt traps operated in the lower reaches of Tenmile Creek by the Oregon Dpartment of Fish and Wildlife (ODFW).

c. **Puget Sound Recovery Domain.** Critical habitat has been designated in Puget Sound for PS Chinook salmon, HC summer-run chum salmon, LO sockeye salmon, and southern green sturgeon, and eulachon, and proposed for PS steelhead. Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency and the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and large wood recruitment (Shared Strategy for Puget Sound 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water which ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Shared Strategy for Puget Sound 2007; Spence et al. 1996).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of turbidity, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (Shared Strategy for Puget Sound 2007).
Peak stream flows have increased over time due to paving (roads and parking areas), *reduced percolation through surface soils on residential and agricultural lands, simplified* and extended drainage networks, loss of

wetlands, and rain-on-snow events in higher elevation clear cuts (Shared Strategy for Puget Sound 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist et al. 1996).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS Chinook salmon populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat (e.g., Elwha River dams block anadromous fish access to 70 miles of potential habitat) changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and large wood to downstream areas (Shared Strategy for Puget Sound 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system (WDFW 2009). Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (Shared Strategy for Puget Sound 2007).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (Shared Strategy for Puget Sound 2007).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (Hood Canal Coordinating Council 2005; Shared Strategy for Puget Sound 2007).

The Ozette Lake tributary basin is 77 mi^2 and includes several large tributaries and numerous smaller tributaries. Currently, land ownership in the watershed is 73% private land, 15% Olympic National Park, 11% Washington State, and 1% Tribal. Natural disturbance in the watershed was dominated by wind and hydrogeomorphic events, while contemporary disturbance additionally includes logging, road construction and maintenance, residential and agricultural development, stream channelization and direct and indirect stream wood clearance. These activities alter stream flow patterns and elevate of sediment loads and increased sedimentation within drainage basins. Wood removal has resulted in less hydraulic roughness, reduced instream water depths, and reduced backwater effects on Lake Ozette, which has thus altered the entire hydraulic control on Lake Ozette levels and changed the in-river stage-discharge relationship. More recently, deposition of sediment originating from Coal Creek at the lake outlet has further altered lake and river levels (Haggerty et al. 2009).

Private timber companies own approximately 93% of the four largest tributary watersheds to Lake Ozette. Logging accelerated over the period of record, with 8.7% of the entire Ozette Lake basin clear-cut by 1953, increasing to 83.6% of the basin area clear-cut by 2003 (Haggerty et al. 2009). Effects associated with logging depended on stream size, gradient, and time after harvest. In high-energy coast streams, landslides and debris torrents often modify steep slope tributaries and the mainstem of creeks. Bank erosion also alters the stream channel on the alluvial flood plain. These effects are additive in the system and reduced the quality of spawning and rearing habitat for juvenile salmonids (Hartman et al. 1996). Lower gradient streams typically will have an accumulation of sediment. Second-growth logged sections (12-35 years after logging), re-shaded by deciduous forest canopy, have lower biomass of trout and fewer predator taxa than old-growth sites (Murphy and Hall 1981). Based on the quantity and quality of the physical and biological features, the CHART assessed the conservation value of the Ozette Lake HUC_5 watershed (#1710010102) for sockeye salmon to be “high” (NOAA Fisheries 2005a).

In summary, critical habitat throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, intense urbanization, agriculture, alteration of floodplain and stream morphology (*i.e.*, , channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors in areas of critical habitat.

The PS recovery domain CHART determined that only a few watersheds with PCEs for Chinook salmon in the Whidbey Basin (Skagit River/Gorge Lake, Cascade River, Upper Sauk River, and the Tye and Beckler rivers) are in good to excellent condition with no potential for improvement. Most HUC_5 watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement (Table 39).

Table 39 – Puget Sound Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and chum salmon (CM) (NOAA Fisheries 2005a). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1
Whidbey Basin and Central/South Basin #1711001xxx			
Lower Snoqualmie River (004), Snohomish (102), Upper White (401) & Carbon (403) rivers	CK	2	2
Middle Fork Snoqualmie (003) & Cedar rivers (201), Lake Sammamish (202), Middle Green River (302) & Lowland Nisqually (503)	CK	2	1
Pilchuck (101), Upper Green (301), Lower White (402), & Upper Puyallup River (404) rivers, & Mashel/Ohop(502)	CK	1	2
Lake Washington (203), Sammamish (204) & Lower Green (303) rivers	CK	1	1
Puyallup River (405)	CK	0	2

Table 39 (continued) – Puget Sound Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and chum salmon (CM) (NOAA Fisheries 2005a). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Hood Canal #1711001xxx			
Dosewallips River (805)	CK/CM	2	1/2
Kitsap – Kennedy/Goldsborough (900)	CK	2	1
Hamma Hamma River (803)	CK/CM	1/2	1/2
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1

d. **Willamette-Lower Columbia Recovery Domain.** Critical habitat was designated in the WLC recovery domain for UWR spring-run Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, CR chum salmon, southern green sturgeon, and eulachon, and proposed for LCR coho salmon. In addition to the Willamette and Columbia River mainstems, important tributaries on the Oregon side of the WLC include Youngs Bay, Big Creek, Clatskanie River, and Scappoose River in the Oregon Coast subbasin; Hood River in the Gorge; and the Sandy, Clackamas, Molalla, North and South Santiam, Calapooia, McKenzie, and Middle Fork Willamette rivers in the West Cascades subbasin.

Land management activities have severely degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high density urban development and widespread agricultural effects have reduced aquatic and riparian habitat quality and complexity, and altered sediment and water quality and quantity, and watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75%. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Logging in the Cascade and Coast Ranges, and agriculture, urbanization, and gravel mining on valley floors have contributed to increased erosion and sediment loads throughout the WLC domain.

The mainstem Willamette River has been channelized and stripped of large wood. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). Gregory (2002a) calculated that the total mainstem Willamette River channel area decreased from 41,000 to 23,000 acres between 1895 and 1995. They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to 120) incurred losses of 12% primary channel area, 16% side channels, 33% alcoves, and 9% islands. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40% of both channel length and channel area were lost, along with 21% of the primary channel, 41% of side channels, 74% of alcoves, and 80% of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the ACOE. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26% of the total length is revetted, 65% of the meander bends are revetted (Gregory et al. 2002b). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al.* 2002b).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory et al. 2002c). Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of large wood in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, organic inputs from litter fall, entrained allochthonous materials, and flood flow filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Gregory et al. (2002c) described the changes in riparian vegetation in river reaches from the mouth to Newberg, from Newberg to Albany, and from

Albany to Eugene. They noted that the riparian forests were formerly a mosaic of brush, marsh, and ash tree openings maintained by annual flood inundation. Below the City of Newberg, the most noticeable change was that conifers were almost eliminated. Above Newberg, the formerly hardwood-dominated riparian forests along with mixed forest made up less than half of the riparian vegetation by 1990, while agriculture dominated. This conversion has reduced river shading and the potential for recruitment of wood to the river, reducing channel complexity and the quality of rearing, migration and spawning habitats.

Hyporheic flow in the Willamette River has been examined through discharge measurements and found to be significant in some areas, particularly those with gravel deposits (Fernald et al. 2001; Wentz et al. 1998). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald et al. 2001).

On the mainstem of the Columbia River, hydropower projects, including the Federal Columbia River Hydropower System (FCRPS), have significantly degraded salmon and steelhead habitats (Bottom et al. 2005; Fresh et al. 2005; NMFS 2011c; NMFS 2012a). The series of dams and reservoirs that make up the FCRPS block an estimated 12 million cubic yards of debris and sediment that would otherwise naturally flow down the Columbia River and replenish shorelines along the Washington and Oregon coasts.

Industrial harbor and port development are also significant influences on the Lower Willamette and Lower Columbia rivers (Bottom et al. 2005; Fresh et al. 2005; NMFS 2011c; NMFS 2012a). Since 1878, 100 miles of river channel within the mainstem Columbia River, its estuary, and Oregon's Willamette River have been dredged as a navigation channel by the ACOE. Originally dredged to a 20-foot minimum depth, the Federal navigation channel of the Lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The Lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, high levels of several sediment chemicals, such as arsenic and polycyclic aromatic hydrocarbons (PAHs), have been identified in Lower Columbia River watersheds in the vicinity of the ports and associated industrial facilities.

The most extensive urban development in the Lower Columbia River subbasin has occurred in the Portland/Vancouver area. Outside of this major urban area, the majority of residences and businesses rely on septic systems. Common water quality issues with urban development and residential septic systems include higher water temperatures, lowered dissolved oxygen, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff.

The Columbia River estuary has lost a significant amount of the tidal marsh and tidal swamp habitats that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom et al. 2005; Fresh et al. 2005; NMFS 2011c; NMFS 2012a). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates which feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming habitat for salmon and steelhead during flooding river discharges or flood tides. Sherwood *et al.* (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production.

Habitat and food-web changes within the estuary, and other factors affecting salmon population structure and life histories, have altered the estuary’s capacity to support juvenile salmon (Bottom et al. 2005; Fresh et al. 2005; NMFS 2011c; NMFS 2012a). Diking and filling activities have reduced the tidal prism and eliminate emergent and forested wetlands and floodplain habitats. These changes have likely reduced the estuary’s salmon-rearing capacity. Moreover, water and sediment in the Lower Columbia River and its tributaries have toxic contaminants that are harmful to aquatic resources (Lower Columbia River Estuary Partnership 2007). Contaminants of concern include dioxins and furans, heavy metals, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. Simplification of the population structure and life-history diversity of salmon possibly is yet another important factor affecting juvenile salmon viability. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns have likely begun to enhance the estuary’s productive capacity for salmon, although historical changes in population structure and salmon life histories may prevent salmon from making full use of the productive capacity of estuarine habitats.

The WLC recovery domain CHART determined that most HUC_5 watersheds with PCEs for salmon or steelhead are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement. Only watersheds in the upper McKenzie River and its tributaries are in good to excellent condition with no potential for improvement (Table 40).

Table 40 – Willamette-Lower Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK), chum salmon (CM), and steelhead (ST) (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Columbia Gorge #1707010xxx			
Wind River (511)	CK/ST	2/2	2/2
East Fork Hood (506), & Upper (404) & Lower Cispus (405) rivers	CK/ST	2/2	2/2
Plympton Creek (306)	CK	2	2
Little White Salmon River (510)	CK	2	0
Grays Creek (512) & Eagle Creek (513)	CK/CM/ST	2/1/2	1/1/2
White Salmon River (509)	CK/CM	2/1	1/2
West Fork Hood River (507)	CK/ST	1/2	2/2
Hood River (508)	CK/ST	1/1	2/2
Unoccupied habitat: Wind River (511)	Chum conservation value "Possibly High"		
Cascade and Coast Range #1708000xxx			
Lower Gorge Tributaries (107)	CK/CM/ST	2/2/2	2/3/2
Lower Lewis (206) & North Fork Toutle (504) rivers	CK/CM/ST	1/3/1	2/1/2
Salmon (101), Zigzag (102), & Upper Sandy (103) rivers	CK/ST	2/2	2/2
Big Creek (602)	CK/CM	2/2	2/2
Coweeman River (508)	CK/CM/ST	2/2/1	2/1/2
Kalama River (301)	CK/CM/ST	1/2/2	2/1/2
Cowlitz Headwaters (401)	CK/ST	2/2	1/1
Skamokawa/Elochoman (305)	CK/CM	2/1	2
Salmon Creek (109)	CK/CM/ST	1/2/1	2/3/2
Green (505) & South Fork Toutle (506) rivers	CK/CM/ST	1/1/2	2/1/2
Jackson Prairie (503) & East Willapa (507)	CK/CM/ST	1/2/1	1/1/2
Grays Bay (603)	CK/CM	1/2	2/3
Upper Middle Fork Willamette River (101)	CK	2	1
Germany/Abernathy creeks (304)	CK/CM	1/2	2
Mid-Sandy (104), Bull Run (105), & Lower Sandy (108) rivers	CK/ST	1/1	2/2
Washougal (106) & East Fork Lewis (205) rivers	CK/CM/ST	1/1/1	2/1/2

Table 40 (continued) – Willamette-Lower Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK), chum salmon (CM), and steelhead (ST) (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Cascade and Coast Range #1708000xxx			
Upper Cowlitz (402) & Tilton rivers (501) & Cowlitz Valley Frontal (403)	CK/ST	1/1	2/1
Clatskanie (303) & Young rivers (601)	CK	1	2
Rifle Reservoir (502)	CK/ST	1	1
Beaver Creek (302)	CK	0	1
Unoccupied Habitat: Upper Lewis (201) & Muddy (202) rivers; Swift (203) & Yale (204) reservoirs	CK & ST Conservation Value "Possibly High"		
Willamette River #1709000xxx			
Upper (401) & South Fork (403) McKenzie rivers; Horse Creek (402); & McKenzie River/Quartz Creek (405)	CK	3	3
Lower McKenzie River (407)	CK	2	3
South Santiam River (606)	CK/ST	2/2	1/3
South Santiam River/Foster Reservoir (607)	CK/ST	2/2	1/2
North Fork of Middle Fork Willamette (106) & Blue (404) rivers	CK	2	1
Upper South Yamhill River (801)	ST	2	1
Little North Santiam River (505)	CK/ST	1/2	3/3
Upper Molalla River (905)	CK/ST	1/2	1/1
Abernethy Creek (704)	CK/ST	1/1	1/2
Luckiamute River (306) & Yamhill (807) Lower Molalla (906) rivers; Middle (504) & Lower (506) North Santiam rivers; Hamilton Creek/South Santiam River (601); Wiley Creek (608); Mill Creek/Willamette River (701); & Willamette River/Chehalem Creek (703); Lower South (804) & North (806) Yamhill rivers; & Salt Creek/South Yamhill River (805)	CK/ST	1	1
Hills (102) & Salmon (104) creeks; Salt Creek/Willamette River (103), Hills Creek Reservoir (105), Middle Fork Willamette/Lookout Point (107); Little Fall (108) & Fall (109) creeks; Lower Middle Fork of Willamette (110), Long Tom (301), Marys (305) & Mohawk (406) rivers	CK	1	1
Willamina Creek (802) & Mill Creek/South Yamhill River (803)	ST	1	1
Calapooia River (303); Oak (304) Crabtree (602), Thomas (603) & Rickreall (702) creeks; Abiqua (901), Butte (902) & Rock (903) creeks/Pudding River; & Senecal Creek/Mill Creek (904)	CK/ST	1/1	0/1
Row River (201), Mosby (202) & Muddy (302) creeks, Upper (203) & Lower (205) Coast Fork Willamette River	CK	1	0
Unoccupied habitat in North Santiam (501) & North Fork Breitenbush (502) rivers; Quartzville Creek (604) and Middle Santiam River (605)	CK & ST Conservation Value "Possibly High"		
Unoccupied habitat in Detroit Reservoir/Blowout Divide Creek (503)	Conservation Value: CK "Possibly Medium"; ST Possibly High"		

Table 40 (continued) – Willamette-Lower Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK), chum salmon (CM), and steelhead (ST) (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Lower Willamette #1709001xxx			
Collawash (101), Upper Clackamas (102), & Oak Grove Fork (103) Clackamas rivers	CK/ST	2/2	3/2
Middle Clackamas River (104)	CK/ST	2/1	3/2
Eagle Creek (105)	CK/ST	2/2	1/2
Gales Creek (002)	ST	2	1
Lower Clackamas River (106) & Scappoose Creek (202)	CK/ST	1	2
Dairy (001) & Scoggins (003) creeks; Rock Creek/Tualatin River (004); & Tualatin River (005)	ST	1	1
Johnson Creek (201)	CK/ST	0/1	2/2
Lower Willamette/Columbia Slough (203)	CK/ST	0	2

e. **Interior Columbia Recovery Domain.** Critical habitat has been designated in the IC recovery domain, which includes the Snake River Basin, for SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, UCR spring-run Chinook salmon, SR sockeye salmon, MCR steelhead, UCR steelhead, and SRB steelhead. Major tributaries in the Oregon portion of the IC recovery domain include the Deschutes, John Day, Umatilla, Walla Walla, Grande Ronde, and Imnaha rivers.

Habitat quality in tributary streams in the IC recovery domain varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (NMFS 2009b; Wissmar et al. 1994). Critical habitat throughout much of the IC recovery domain has been degraded by intense agriculture, alteration of stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas.

Migratory habitat quality in this area has been severely affected by the development and operation of the FCRPS dams and reservoirs in the mainstem Columbia River, Bureau of Reclamation tributary projects, and privately owned dams in the Snake and Upper Columbia river basins. For example, construction of Hells Canyon Dam eliminated access to several likely production areas in Oregon and Idaho, including the Burnt, Powder, Weiser, Payette, Malheur, Owyhee, and Boise river basins (Good et al. 2005), and Grand Coulee and Chief Joseph dams completely block anadromous fish passage on the upper mainstem Columbia River. Hydroelectric development modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

Similarly, development and operation of extensive irrigation systems and dams for water withdrawal and storage in tributaries have altered hydrological cycles. A series of large regulating dams on the middle and upper Deschutes River affect flow and block access to upstream habitat, and have extirpated one or more populations from the Cascades Eastern Slope major population (IC-TRT 2003). Similarly, operation and maintenance of large water reclamation systems such as the Umatilla Basin and Yakima Projects have significantly reduced flows and degraded water quality and physical habitat in this domain.

Many stream reaches designated as critical habitat in the IC recovery domain are over-allocated under state water law, with more allocated water rights than existing streamflow. Withdrawal of water, particularly during low-flow periods that commonly overlap with agricultural withdrawals, often increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence et al. 1996). Reduced tributary stream flow has been identified as a major limiting factor for all listed salmon and steelhead species in this recovery domain except SR fall-run Chinook salmon and SR sockeye salmon (NMFS 2007a; NOAA Fisheries 2011).

Many stream reaches designated as critical habitat are listed on the state of Oregon’s Clean Water Act section 303(d) list for water temperature. Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevated stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

The IC recovery domain is a very large and diverse area. The CHART determined that few watersheds with PCEs for Chinook salmon or steelhead are in good to excellent condition with no potential for improvement. Overall, most IC recovery domain watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or high potential for improvement. In Washington, the Upper Methow, Lost, White, and Chiwawa watersheds are in good-to-excellent condition with no potential for improvement. In Oregon, only the Lower Deschutes, Minam, Wenaha, and Upper and Lower Imnaha Rivers HUC_5 watersheds are in good-to-excellent condition with no potential for improvement. In Idaho, a number of watersheds with PCEs for steelhead (Upper Middle Salmon, Upper Salmon/Pahsimeroi, Middle Fork Salmon, Little Salmon, Selway, and Lochsa rivers) are in good-to-excellent condition with no potential for improvement. Additionally, several Lower Snake River HUC_5watersheds in the Hells Canyon area, straddling Oregon and Idaho, are in good-to-excellent condition with no potential for improvement (Table 41).

Table 41 – Interior Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005a). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Upper Columbia # 1702000xxx			
White (101), Chiwawa (102), Lost (801) & Upper Methow (802) rivers	CK/ST	3	3
Upper Chewuch (803) & Twisp rivers (805)	CK/ST	3	2
Lower Chewuch River (804); Middle (806) & Lower (807) Methow rivers	CK/ST	2	2
Salmon Creek (603) & Okanogan River/Omak Creek (604)	ST	2	2
Upper Columbia/Swamp Creek (505)	CK/ST	2	1
Foster Creek (503) & Jordan/Tumwater (504)	CK/ST	1	1
Upper (601) & Lower (602) Okanogan River; Okanogan River/Bonaparte Creek (605); Lower Similkameen River (704); & Lower Lake Chelan (903)	ST	1	1
Unoccupied habitat in Sinlahekin Creek (703)	ST Conservation Value "Possibly High"		
Upper Columbia #1702001xxx			
Entiat River (001); Nason/Tumwater (103); & Lower Wenatchee River (105)	CK/ST	2	2
Lake Entiat (002)	CK/ST	2	1
Columbia River/Lynch Coulee (003); Sand Hollow (004); Yakima/Hansen Creek (604), Middle Columbia/Priest Rapids (605), & Columbia River/Zintel Canyon (606)	ST	2	1
Icicle/Chumstick (104)	CK/ST	1	2
Lower Crab Creek (509)	ST	1	2
Rattlesnake Creek (204)	ST	0	1
Yakima #1703000xxx			
Upper (101) & Middle (102) Yakima rivers; Teanaway (103) & Little Naches (201) rivers; Naches River/Rattlesnake Creek (202); & Ahtanum (301) & Upper Toppenish (303) & Satus (305) creeks	ST	2	2
Umtanum/Wenas (104); Naches River/Tieton River (203); Upper Lower Yakima River (302); & Lower Toppenish Creek (304)	ST	1	2
Yakima River/Spring Creek (306)	ST	1	1

Table 41(continued) – Interior Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005a). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Lower Snake River #1706010xxx			
Snake River/Granite (101), Getta (102), & Divide (104) creeks; Upper (201) & Lower (205) Imnaha River; Snake River/Rogersburg (301); Minam (505) & Wenaha (603) rivers	ST	3	3
Grande Ronde River/Rondowa (601)	ST	3	2
Big (203) & Little (204) Sheep creeks; Asotin River (302); Catherine Creek (405); Lostine River (502); Bear Creek (504); & Upper (706) & Lower (707) Tucannon River	ST	2	3
Middle Imnaha River (202); Snake River/Captain John Creek (303); Upper Grande Ronde River (401); Meadow (402); Beaver (403); Indian (409), Lookingglass (410) & Cabin (411) creeks; Lower Wallowa River (506); Mud (602), Chesnimnus (604) & Upper Joseph (605) creeks	ST	2	2
Ladd Creek (406); Phillips/Willow Creek (408); Upper (501) & Middle (503) Wallowa rivers; & Lower Grande Ronde River/Menatche Creek (607)	ST	1	3
Five Points (404); Lower Joseph (606) & Deadman (703) creeks	ST	1	2
Tucannon/Alpowa Creek (701)	ST	1	1
Mill Creek (407)	ST	0	3
Pataha Creek (705)	ST	0	2
Snake River/Steptoe Canyon (702) & Penawawa Creek (708)	ST	0	1
Flat Creek (704) & Lower Palouse River (808)	ST	0	0
Upper Salmon and Pahsimeroi #1706020xxx			
Germania (111) & Warm Springs (114) creeks; Lower Pahsimeroi River (201); Alturas Lake (120), Redfish Lake (121), Upper Valley (123) & West Fork Yankee (126) creeks	ST	3	3
Basin Creek (124)	ST	3	2
Salmon River/Challis (101); East Fork Salmon River/McDonald Creek (105); Herd Creek (108); Upper East Fork Salmon River (110); Salmon River/Big Casino (115), Fisher (117) & Fourth of July (118) creeks; Upper Salmon River (119); Valley Creek/Iron Creek (122); & Morgan Creek (132)	ST	2	3
Salmon River/Bayhorse Creek (104); Salmon River/Slate Creek (113); Upper Yankee Fork (127) & Squaw Creek (128); Pahsimeroi River/Falls Creek (202)	ST	2	2
Yankee Fork/Jordan Creek (125)	ST	1	3
Salmon River/Kinnikinnick Creek (112); Garden Creek (129); Challis Creek/Mill Creek (130); & Patterson Creek (203)	ST	1	2
Road Creek (107)	ST	1	1
Unoccupied habitat in Hawley (410), Eighteenmile (411) & Big Timber (413) creeks	Conservation Value for ST "Possibly High"		

Table 41 (continued) – Interior Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005a). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Middle Salmon, Panther and Lemhi #1706020xxx			
Salmon River/Colson (301), Pine (303) & Moose (305) creeks; Indian (304) & Carmen (308) creeks, North Fork Salmon River (306); & Texas Creek (412)	ST	3	3
Deep Creek (318)	ST	3	2
Salmon River/Cow Creek (312) & Hat (313), Iron (314), Upper Panther (315), Moyer (316) & Woodtick (317) creeks; Lemhi River/Whimpey Creek (402); Hayden (414), Big Eight Mile (408), & Canyon (408) creeks	ST	2	3
Salmon River/Tower (307) & Twelvemile (311) creeks; Lemhi River/Kenney Creek (403); Lemhi River/McDevitt (405), Lemhi River/Yearian Creek (406); & Peterson Creek (407)	ST	2	2
Owl (302) & Napias (319) creeks	ST	2	1
Salmon River/Jesse Creek (309); Panther Creek/Trail Creek (322); & Lemhi River/Bohannon Creek (401)	ST	1	3
Salmon River/Williams Creek (310)	ST	1	2
Agency Creek (404)	ST	1	1
Panther Creek/Spring Creek (320) & Clear Creek (323)	ST	0	3
Big Deer Creek (321)	ST	0	1
Mid-Salmon-Chamberlain, South Fork, Lower, and Middle Fork Salmon #1706020xxx			
Lower (501), Upper (503) & Little (504) Loon creeks; Warm Springs (502); Rapid River (505); Middle Fork Salmon River/Soldier (507) & Lower Marble Creek (513); & Sulphur (509), Pistol (510), Indian (511) & Upper Marble (512) creeks; Lower Middle Fork Salmon River (601); Wilson (602), Upper Camas (604), Rush (610), Monumental (611), Beaver (614), Big Ramey (615) & Lower Big (617) creeks; Middle Fork Salmon River/Brush (603) & Sheep (609) creeks; Big Creek/Little Marble (612); Crooked (616), Sheep (704), Bargamin (709), Sabe (711), Horse (714), Cottonwood (716) & Upper Chamberlain Creek (718); Salmon River/Hot Springs (712); Salmon River/Kitchen Creek (715); Lower Chamberlain/McCalla Creek (717); & Slate Creek (911)	ST	3	3
Marsh (506); Bear Valley (508) Yellow Jacket (604); West Fork Camas (607) & Lower Camas (608) creeks; & Salmon River/Disappointment Creek (713) & White Bird Creek (908)	ST	2	3
Upper Big Creek (613); Salmon River/Fall (701), California (703), Trout (708), Crooked (705) & Warren (719) creeks; Lower South Fork Salmon River (801); South Fork Salmon River/Cabin (809), Blackmare (810) & Fitsum (812) creeks; Lower Johnson Creek (805); & Lower (813), Middle (814) & Upper Secesh (815) rivers; Salmon River/China (901), Cottonwood (904), McKenzie (909), John Day (912) & Lake (913) creeks; Eagle (902), Deer (903), Skookumchuck (910), French (915) & Partridge (916) creeks	ST	2	2

Table 41(continued) – Interior Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005a). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Mid-Salmon-Chamberlain, South Fork, Lower, and Middle Fork Salmon #1706020xxx			
Wind River (702), Salmon River/Rabbit (706) & Rattlesnake (710) creeks; & Big Mallard Creek (707); Burnt Log (806), Upper Johnson (807) & Buckhorn (811) creeks; Salmon River/Deep (905), Hammer (907) & Van (914) creeks	ST	2	1
Silver Creek (605)	ST	1	3
Lower (803) & Upper (804) East Fork South Fork Salmon River; Rock (906) & Rice (917) creeks	ST	1	2
Little Salmon #176021xxx			
Rapid River (005)	ST	3	3
Hazard Creek (003	ST	3	2
Boulder Creek (004)	ST	2	3
Lower Little Salmon River (001) & Little Salmon River/Hard Creek (002)	ST	2	2
Selway, Lochsa and Clearwater #1706030xxx			
Selway River/Pettibone (101) & Gardner (103) creeks; Bear (102), White Cap (104), Indian (105), Burnt Knob (107), Running (108) & Goat (109) creeks; & Upper Selway River (106); Gedney (202), Upper Three Links (204), Rhoda (205), North Fork Moose (207), Upper East Fork Moose (209) & Martin (210) creeks; Upper (211), Middle (212) & Lower Meadow (213) creeks; Selway River/Three Links Creek (203); & East Fork Moose Creek/Trout Creek (208); Fish (302), Storm (309), Warm Springs (311), Fish Lake (312), Boulder (313) & Old Man (314) creeks; Lochsa River/Stanley (303) & Squaw (304) creeks; Lower Crooked (305), Upper Crooked (306) & Brushy (307) forks; Lower (308), Upper (310) White Sands, Ten Mile (509) & John's (510) creeks	ST	3	3
Selway River/Goddard Creek (201); O'Hara Creek (214) Newsome (505) creeks; American (506), Red (507) & Crooked (508) rivers	ST	2	3
Lower Lochsa River (301); Middle Fork Clearwater River/Maggie Creek (401); South Fork Clearwater River/Meadow (502) & Leggett creeks; Mill (511), Big Bear (604), Upper Big Bear (605), Musselshell (617), Eldorado (619) & Mission (629) creeks, Potlatch River/Pine Creek (606); & Upper Potlatch River (607); Lower (615), Middle (616) & Upper (618) Lolo creeks	ST	2	2
South Fork Clearwater River/Peasley Creek (502)	ST	2	1
Upper Orofino Creek (613)	ST	2	0
Clear Creek (402)	ST	1	3
Three Mile (512), Cottonwood (513), Big Canyon (610), Little Canyon (611) & Jim Ford (614) creeks; Potlatch River/Middle Potlatch Creek (603); Clearwater River/Bedrock (608), Jack's (609) Lower Lawyer (623), Middle Lawyer (624), Cottonwood (627) & Upper Lapwai (628) creeks; & Upper (630) & Lower (631) Sweetwater creeks	ST	1	2
Lower Clearwater River (601) & Clearwater River/Lower Potlatch River (602), Fivemile Creek (620), Sixmile Creek (621) and Tom Taha (622) creeks	ST	1	1

Table 41 (continued) – Interior Columbia Recovery Domain: Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and steelhead (ST) (NOAA Fisheries 2005a). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Mid-Columbia #1707010xxx			
Wood Gulch (112); Rock Creek (113); Upper Walla Walla (201), Upper Touchet (203), & Upper Umatilla (301) rivers; Meacham (302) & Birch (306) creeks; Upper (601) & Middle (602) Klickitat River	ST	2	2
Glade (105) & Mill (202) creeks; Lower Klickitat River (604); Mosier Creek (505); White Salmon River (509); Middle Columbia/Grays Creek (512)	ST	2	1
Little White Salmon River (510)	ST	2	0
Middle Touchet River (204); McKay Creek (305); Little Klickitat River (603);Fifteenmile (502) & Fivemile (503) creeks	ST	1	2
Alder (110) & Pine (111) creeks; Lower Touchet River (207), Cottonwood (208), Pine (209) & Dry (210) creeks; Lower Walla Walla River (211); Umatilla River/Mission Creek (303) Wildhorse Creek (304); Umatilla River/Alkali Canyon (307); Lower Butter Creek (310); Upper Middle Columbia/Hood (501); Middle Columbia/Mill Creek (504)	ST	1	1
Stage Gulch (308) & Lower Umatilla River (313)	ST	0	1
John Day #170702xxx			
Middle (103) & Lower (105) South Fork John Day rivers; Murderers (104) & Canyon (107) creeks; Upper John Day (106) & Upper North Fork John Day (201) rivers; & Desolation Creek (204)	ST	2	2
North Fork John Day/Big Creek (203); Cottonwood Creek (209) & Lower NF John Day River (210)	ST	2	1
Strawberry (108), Beech (109), Laycock (110), Fields (111), Mountain (113) & Rock (114) creeks; Upper Middle John Day River (112); Granite (202) & Wall (208) creeks; Upper (205) & Lower (206) Camas creeks; North Fork John Day/Potamus Creek (207); Upper Middle Fork John Day River (301) & Camp (302), Big (303) & Long (304) creeks; Bridge (403) & Upper Rock (411) creeks; & Pine Hollow (407)	ST	1	2
John Day/Johnson Creek (115); Lower Middle Fork John Day River (305); Lower John Day River/Kahler Creek (401), Service (402) & Muddy (404) creeks; Lower John Day River/Clarno (405); Butte (406), Thirtymile (408) & Lower Rock (412) creeks; Lower John Day River/Ferry (409) & Scott (410) canyons; & Lower John Day River/McDonald Ferry (414)	ST	1	1
Deschutes #1707030xxx			
Lower Deschutes River (612)	ST	3	3
Middle Deschutes River (607)	ST	3	2
Upper Deschutes River (603)	ST	2	1
Mill Creek (605) & Warm Springs River (606)	ST	2	1
Bakeoven (608) & Buck Hollow (611) creeks; Upper (701) & Lower (705) Trout Creek	ST	1	2
Beaver (605) & Antelope (702) creeks	ST	1	1
White River (610) & Mud Springs Creek (704)	ST	1	0
Unoccupied habitat in Deschutes River/McKenzie Canyon (107) & Haystack (311); Squaw Creek (108); Lower Metolius River (110), Headwaters Deschutes River (601)	ST Conservation Value "Possibly High"		

f. **Oregon Coast Recovery Domain.** In this recovery domain, critical habitat has been designated for OC coho salmon, southern green sturgeon, and eulachon. Many large and small rivers supporting significant populations of coho salmon flow through this domain, including the Nehalem, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, and Coquille.

The historical disturbance regime in the central Oregon Coast Range was dominated by a mixture of high and low-severity fires, with a natural rotation of approximately 271 years. Old-growth forest coverage in the Oregon Coast Range varied from 25 to 75% during the past 3,000 years, with a mean of 47%, and never fell below 5% (Wimberly et al. 2000). Currently, the Coast Range has approximately 5% old-growth, almost all of it on Federal lands. The dominant disturbance now is logging on a cycle of approximately 30 to 100 years, with fires suppressed.

Oregon's assessment of OC coho salmon (Nicholas *et al.* 2005) mapped how streams with high intrinsic potential for rearing are distributed by land ownership categories. Agricultural lands and private industrial forests have by far the highest percentage of land ownership in high intrinsic potential areas and along all coho salmon stream miles. Federal lands have only about 20% of coho salmon stream miles and 10% of high intrinsic potential stream reaches. Because of this distribution, activities in lowland agricultural areas are particularly important to the conservation of OC coho salmon.

The OC coho salmon assessment concluded that at the scale of the entire domain, pools are generally abundant, although slow-water and off-channel habitat (which are important refugia for coho salmon during high winter flows) are limited in the majority of streams when compared to reference streams in minimally-disturbed areas. Amounts of large wood in streams are low in all four ODFW monitoring areas and land-use types relative to reference conditions. Amounts of fine sediment are high in three of the four monitoring areas, and were comparable to reference conditions only on public lands. Approximately 62 to 91% of tidal wetland acres (depending on estimation procedures) have been lost for functionally and potentially independent populations of coho salmon.

As part of the coastal coho salmon assessment, the Oregon Department of Environmental Quality analyzed the status and trends of water quality in the range of OC coho salmon using the Oregon water quality index, which is based on a combination of temperature, dissolved oxygen, biological oxygen demand, pH, total solids, nitrogen, total phosphates, and bacteria. Using the index at the species scale, 42% of monitored sites had excellent to good water quality, and 29% show poor to very poor water quality. Within the four monitoring areas, the North Coast had the best overall conditions (six sites in excellent or good condition out of nine sites), and the Mid-South coast had the poorest conditions (no excellent condition sites, and only two out of eight sites in good condition). For the 10-year period monitored between 1992 and 2002, no sites showed a declining trend in water quality. The area with the most improving trends was the North Coast, where 66% of the sites (six out of nine) had a significant improvement in index scores. The Umpqua River basin, with one out of nine sites (11%) showing an improving trend, had the lowest number of improving sites.

g. **Southern Oregon/Northern California Coasts Recovery Domain.** In this recovery domain critical habitat has been designated for SONCC coho salmon, southern green sturgeon, and eulachon. Many large and small rivers supporting significant populations of coho salmon flow through this area, including the Elk, Rogue, Chetco, Smith and Klamath. The following summary of critical habitat information in the Elk, Rogue, and Chetco rivers is also applicable to habitat characteristics and limiting factors in other basins in this area.

The Elk River flows through Curry County, and drains approximately 92 square miles (or 58,678 acres) (Maguire 2001). Historical logging, mining, and road building have degraded stream and riparian habitats in the Elk River basin. Limiting factors identified for salmon and steelhead production in this basin include sparse riparian cover, especially in the lower reaches, excessive fine sediment, high water temperatures, and noxious weed invasions (Maguire 2001).

The Rogue River drains approximately 5,160 square miles within Curry, Jackson and Josephine counties in southwest Oregon. The mainstem is about 200 miles long and traverses the coastal mountain range into the Cascades. The Rogue River estuary has been modified from its historical condition. Jetties were built by the ACOE in 1960, which stabilized and deepened the mouth of the river. A dike that extends from the south shore near Highway 101 to the south jetty was completed in 1973. This dike created a backwater for the large shallow area that existed here, which has been developed into a boat basin and marina, eliminating most of the tidal marsh.

The quantity of estuary habitat is naturally limited in the Rogue River. The Rogue River has a drainage area of 5,160 square miles, but the estuary at 1,880 acres is one of the smallest in Oregon. Between 1960 and 1972, approximately 13 acres of intertidal and 14 acres of subtidal land were filled in to build the boat basin dike, the marina, north shore riprap and the other north shore developments (Hicks 2005). Jetties constructed in 1960 to stabilize the mouth of the river and prevent shoaling have altered the Rogue River, which historically formed a sill during summer months (Hicks 2005).

The Lower Rogue Watershed Council's watershed analysis (Hicks 2005) lists factors limiting fish production in tributaries to Lower Rogue River watershed. The list includes water temperatures, low stream flows, riparian forest conditions, fish passage and over-wintering habitat. Limiting factors identified for the Upper Rogue River basin include fish passage barriers, high water temperatures, insufficient water quantity, lack of large wood, low habitat complexity, and excessive fine sediment (Rogue Basin Coordinating Council 2006).

The Chetco River estuary has been significantly modified from its historical condition. Jetties were erected by the ACOE in 1957, which stabilized and deepened the mouth of the river. These jetties have greatly altered the mouth of the Chetco River and how the estuary functions as habitat for salmon migrating to the ocean. A boat basin and marina were built in the late 1950s and eliminated most of the functional tidal marsh. The structures eliminated shallow water habitats and vegetation in favor of banks stabilized with riprap. Since then, nearly all remaining bank habitat in the estuary has been stabilized with riprap. The factors limiting fish production in the Chetco River appear to be high water temperature caused by lack of shade, especially in tributaries, high rates of sedimentation due to roads, poor over-wintering habitat due to a lack of large wood in tributaries and the mainstem, and poor quality estuary habitat (Maguire 2001).

C. Birds

1. Marbled Murrelet *(Brachyramphus marmoratus)*

Listing Status and Description – The Washington, Oregon, and California marbled murrelet populations were listed as threatened by in 1992 (USDI 1992a). The marbled murrelet is a small seabird that nests along the Pacific Coast from Alaska to central California. Murrelets forage at sea, but nest on large limbs in old-growth coniferous forest.

Population Trends and Distribution – As part of the recovery planning process, a demographic model was developed to help better understand marbled murrelet population dynamics (USFWS 1997)The demographic model predicted that murrelet populations are likely to be declining at an estimated rate of 4 to 7 percent per year. Predicting or estimating population trends for marbled murrelets is difficult because their population dynamics and demography have not been well described. Ralph et al. (1995) summarized some of the reasons for the variability in population estimates among researchers, including differences in methodology, assumptions, spatial coverage, and survey and model errors. Nevertheless, both Ralph et al. (1995) and the Marbled Murrelet Recovery Team (USFWS 1997) have concluded that the listed population appears to be in a long-term downward trend.

Reasons for Decline – Old-growth coniferous forest habitat loss as well as predation by corvids. From 1974 through 1993, approximately 64% of the nests failed where nest success/failure was documented, and 57% of those that failed were due to predation (primarily by ravens, crows, and jays) (USFWS 1997).

Recovery Measures – Critical habitat was designated for the species in May 1996 (USDI 1996a), then revised on October 5, 2011(76 FR 61599). Six conservation zones for marbled murrelets were identified in the Marbled Murrelet Recovery Plan (USFWS 1997).

2. **Northern Spotted Owl *(Strix occidentalis caurina)***
Listing Status and Description – The northern spotted owl was listed as a threatened species throughout its range in Washington, Oregon and northern California in 1990 (USDI 1990).

Population Trends and Distribution – The northern spotted owl is one of three subspecies (northern, California, and Mexican) and occurs from British Columbia to northern California. The northern spotted owl is associated with late successional and old-growth forest habitats. The owl also occurs in some younger forest types where structural attributes of old-growth forests are present (WDNR 1997). The present range of the northern spotted owl is similar to the limits of its historic range (USDI 1992b).

Reasons for Decline – Widespread habitat loss across its entire range from timber harvest and wildfires combined with displacement by barred owls (Strix varia).

Recovery Measures – Critical habitat is based on principles for owl conservation established by Thomas et al. (1990) and included large blocks of suitable owl habitat and/or connectivity between blocks that would support dispersal. The final rule recommended the physiographic province as the primary basis for assessing actions under section 7 of ESA. A complete description of owl critical habitat is found in the final rule designating critical habitat (USDI 1992a). In 2011 a revised spotted owl Recovery Plan was finalized, and another revised critical habitat designation was finalized on December 4, 2012 (77 FR 71876).

D. Mammal

1. Canada Lynx (*Lynx canadensis*)

Listing Status and Description – The Canada lynx was listed as threatened in the contiguous United States on March 24, 2000 (USDI 2000). Canada lynx are specialized predators and their distribution coincides with the snowshoe hare. Studies in the southern portion of lynx range (Koehler 1990; Apps 2000; Squires and Laurion 2000) documented starvation as a primary cause of adult lynx mortality. The same studies reported low kitten survival. The LCAS provided guidance on maintenance of young, dense conifer vegetation to support higher densities of snowshoe hare. The LCAS also discussed the importance of mature, multiple-storied conifer vegetation that has dense horizontal cover at snow/ground level to snowshoe hare. Murray et al. (1994), Buskirk et al. (2000), Parker et al. (1983), and Dolbeer and Clark (1975) also described this condition. These two vegetation conditions, young, dense conifer and older, multi-storied stands, are very important to lynx because they support conditions suitable to higher densities of snowshoe hare.

Population Trends and Distribution – Historically and currently, lynx were and are present in Alaska and Canada from the Yukon and Northwest Territories east to Nova Scotia and New Brunswick and south into the continental U.S. Records document lynx occurrence in 24 states, including Washington and Oregon (McKelvey 2000). In Region 6 of the Forest Service, lynx habitat has been identified on the Okanogan/Wenatchee, Colville, Mt. Baker-Snoqualmie, Malheur, Wallowa-Whitman, Umatilla and Deschutes National Forests. Each National Forest maintains a map of lynx habitat.

Reasons for Decline – In the final listing rule, the Fish and Wildlife Service concluded that the single factor threatening the population was the inadequacy of existing regulatory mechanisms, specifically the lack of guidance for conservation of lynx in National Forest Land and Resource Management Plans and the BLM Land Use Plans.

Recovery Measures – The Canada lynx was listed as threatened in the contiguous United States on March 24, 2000 (USDI 2000). In the final rule, the Fish and Wildlife Service concluded that the single factor threatening the population was the inadequacy of existing regulatory mechanisms, specifically the lack of guidance for conservation of lynx in National Forest Land and Resource Management Plans and the BLM Land Use Plans.

2. **Gray Wolf *(Canis lupus)***

Listing Status and Description – The gray wolf was listed as endangered in 1978. Wolves generally live in packs made up of 2 to 12 or more family members and individuals, led by a dominant male and female. In other locations, denning by wolves generally occurs between April and June. Den sites often have forested cover nearby and are distant from human activity. The pups remain at the den site for the first 6 to 8 weeks, and then they move to a rendezvous site until they are large enough to accompany the adults on a hunt (Peterson 1986). Once the pups are large enough to go hunting, the pack travels throughout its territory.

Population Trends and Distribution – Recent observations indicate that wolves exist in Washington, likely in small numbers, and mostly as individuals. Several family units have been documented, indicating that some level of recolonization has occurred recently (Almack and Fitkin 1998). Olterman and Verts (1972) considered wolves to have been extirpated from Oregon since the last animal was presented for bounty in 1946. However, single animals from the experimental population in Idaho have been sighted in northeastern Oregon within the last five years (including a radio-collared animal). At present, wolves from the Snake River, Imnaha, and Umatilla Packs are known to occur in Oregon.

Reasons for Decline – In 1930, it was believed that breeding populations of wolves in Washington were extinct because of fur trading pressure in the 1800's followed by the establishment of bounties on all predators in 1871 in the Washington Territory (Young and Goldman 1944). In Oregon a bounty of $3 on wolves was established in the Willamette Valley in 1843. The Oregon State Game Commission began offering a $20 wolf bounty in 1913 in addition to the regular $5 paid by the state at the time. During the period 1913-1946, 393 wolves were presented for payment in Oregon (Olterman and Verts 1972). Many of these wolves were taken prior to the mid -1930s and no more than two wolves per year were bountied after 1937. The last record of a wolf submitted for bounty in Oregon was in 1946 for an animal killed in the Umpqua National Forest in southwest Oregon (ODFW 2005).

Recovery Measures – A recovery plan was signed on August 3, 1987. The State of Oregon developed and released a wolf conservation and management plan in 2005, which was updated in 2010. The State of Washington followed releasing their conservation and management plan in December of 2011.

3. **Grizzly bear *(Ursus arctos horribilis)***

Listing Status and Description – The grizzly bear was listed as a threatened species in the conterminous United States in 1975.

Population Trends and Distribution – Historically, in North America, the grizzly's range extended from the mid-plains westward to the California coast and south into Texas and Mexico (USDI 1993a). In Washington, the grizzly's range is limited to the North Cascades and the Selkirk mountains (Mt Baker-Snoqualmie, Okanogan/Wenatchee and Colville NFs). In Oregon, the grizzly bear is considered extirpated (Verts and Carraway 1998). Little is known about the grizzly bears residing in the North Cascades. It is suspected that their habits are similar to bears from other areas.

Reasons for Decline – Livestock depredation control, habitat deterioration, commercial trapping, unregulated hunting, and protection of human life were leading cause of the decline of grizzly bears (USDI 1993a). Human disturbance, usually increased with road access into grizzly habitat, is known to affect bear use of seasonal habitat components. In general, roads increase the probability of bear-human encounters and human induced mortality.

Recovery Measures – Two of the six ecosystems identified in the grizzly bear recovery plan (USDI 1993a) are in Washington, the Northern Cascades Recovery Zone and the Selkirks Recovery Zone. Almack et al. (1993) estimated the 1991 grizzly bear population in the North Cascades recovery area at less than 50, and perhaps as low as 5 to 20.

4. **Woodland Caribou *(Rangifer tarandus caribou)***

Listing Status and Description – The woodland caribou was federally listed as endangered in 1983. Woodland caribou are generally found on moderate slopes above approximately 1,200 m (4,000 feet) elevation in the Selkirk Mountains in Englemann spruce/subalpine fir and western red cedar/western hemlock forest types (USDI 1994a). Caribou use streams, bogs, basins, and other areas that are no more than 35 percent slope and are composed of mature or old-growth timber (Freddy 1974; Simpson and Woods 1987).

Population Trends and Distribution – Prior to 1900, woodland caribou were distributed throughout much of Canada and the northeastern, north-central, and northwestern coterminous United States. Since the 1960's, the woodland caribou population has restricted its range to the Selkirk Mountains of northeastern Washington, northern Idaho and southeastern British Columbia. In Washington State, caribou are found east of the Pend Oreille River in Pend Oreille County.

The recovery area for caribou in the South Selkirk Mountains is comprised of approximately 5,700 km2. About 47 percent of the area lies in British Columbia and 53 percent lies in the United States. The United States portion includes the Salmon-Priest Wilderness and other portions of the Colville and Idaho Panhandle National Forests, Idaho Department of Lands holdings, and scattered private parcels (USDI 1994a). As recently as the 1950s, the South Selkirk Mountains population consisted of an estimated 100 animals (Evans 1960). However, by the early 1980s, the population had declined to 25-30 animals whose distribution centered on Stagleap Provincial Park, British Columbia (Scott and Servheen 1985). Stagleap is a small park located a few miles north of the U.S. - Canadian border.

Reasons for Decline – Habitat fragmentation and loss, predation, poaching, and disease have all contributed to the decline of woodland caribou in North America. The small, South Selkirk Mountains population is extremely vulnerable to predation, accidental deaths and poaching (USDI 1994a). Predation from mountain lions (*Puma concolor*) may have contributed to the decline of the last population of endangered mountain caribou (*Rangifer tarandus caribou*) in the United States (Katnik 2002).

Recovery Measures – The U.S. population was augmented in 1987, 1988, and 1990 by transplanting a total of 60 animals from central British Columbia into northern Idaho. In 1996-1998, a total of 43 woodland caribou were transplanted into northeast Washington and Stagleap Provincial Park. The current population estimate for the ecosystem is 37 animals (Audet pers. com. 2002). Since the late 1980s, habitat for caribou in the ecosystem has been managed according to guidelines developed by the U.S. Forest Service, B.C. Ministry of Environment, and Idaho Department of Lands, which were developed in an attempt "to minimize the effects of logging on caribou and…to develop silvicultural standards that may enhance habitat over the long term." (USDI 1994a). The potential for habitat loss due to large wildfires or insect/disease attack is an ongoing management concern.

E. Plants

1. Howell's spectacular thelypody (*Thelypodium howellii ssp. spectabilis*)

Listing Status and Description– Howell's spectacular thelypody (thelypody) was federally listed on May 26 1999 without Critical Habitat designation. This species is also on the state of Oregon's State Endangered Plant list. A recovery plan was finalized for Howell's spectacular thelypody on June 3, 2002.

Howell's spectacular thelypody is an herbaceous biennial that reaches approximately 60 cm (24 in) tall, with branches arising from near the base of the stem. The basal leaves are approximately 5 cm (2 in) long with wavy edges and are arranged in a rosette. Stem leaves are shorter, narrow, and have smooth edges. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 in) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986a).

The plant flowers in May, fruits in June and goes dormant in August. It is a root forming plant and is pollinated by insects. The thelypody occurs in wet alkaline meadows in valley bottoms, usually in and around woody shrubs that dominate the habitat on the knolls and along the edge of the wet meadow habitat between the knolls. Associated species include *Sarcobatus vermiculatus* (greasewood), *Distichlis stricta* (alkali saltgrass), *Elymus cinereus* (giant wild rye), *Spartina gracilis* (alkali cordgrass), and *Poa juncifolia* (alkali bluegrass) (Kagan 1986a). Soils are pluvial-deposited alkaline clays mixed with recent alluvial silts, and are moderately well-drained (Kagan 1986a). The thelypody may be dependent on periodic flooding since it appears to rapidly colonize areas adjacent to streams that have flooded (Kagan 1986a). In addition, this taxon does not compete well with encroaching weedy vegetation such as *Dipsacus fullonum* (teasel) (Davis and Youtie 1995).

Population Trends and Distribution – This taxon was thought to be extinct until rediscovered by Kagan in 1980 near North Powder (Kagan 1986a). The 11 recently discovered sites containing the thelypody are located near the communities of North Powder, Haines, and Baker. The North Powder thelypody population contains five sites; the largest is subject to a conservation easement 41.4 ac (16.8 ha). Until recently, one site near the town of North Powder, less than 2.3 ac (0.8 ha) in size, had a plant protection agreement between the landowner and The Nature Conservancy. The Haines plant population currently consists of three small sites located in or near the town of Haines. Since the publication of the proposed rule, an additional site in Haines was identified (B. Russell, consultant, in litt. 1998) and one previously known site in Haines was apparently extirpated by development (P. Brooks, Forest Service, in litt. 1998). A 1.8 ac (0.7 ha) site west of Baker is within a 20 ac (8 ha) pasture adjacent to a road. Another site north of Baker 0.08 ac (0.03 ha) exists in a small remnant of meadow habitat surrounded by farmland. One site approximately 8 km (5 mi) north of North Powder is located on private land at Clover Creek (Kagan 1986a).

Reasons for Decline – The thelypody has been extirpated from about one-third of known historic sites, including the type locality in Malheur County. Threats to the taxon include 1) habitat loss due to urban and agricultural development; 2) habitat degradation due to livestock grazing and hydrological modification; 3) consumption by livestock; 4) use of herbicides or mowing during the growing season; and 5) competition with exotic species such as teasel (*Dipsacus fullonum*), bull thistle (*Cirsium vulgare*), Canada thistle (*C. canadensis*), and yellow sweet clover (*Melilotus officinalis*).

Most of the habitat for the thelypody has been modified or lost to urban and agricultural development. Habitat degradation at all remaining sites for this species is due to a combination of livestock grazing, agricultural conversion, hydrological modifications, and competition from non-native vegetation. These activities have resulted in the extirpation of thelypody from about half its former range in Baker, Union, and Malheur counties. Plants at the type locality in Malheur County are considered to be extirpated due to past agricultural development (Kagan 1986a).

Within the City of Haines, all remaining habitat containing thelypody is being impacted by residential construction, trampling, and other activities. In 1994, a large section of habitat formerly occupied by thelypody at the Haines rodeo grounds was destroyed when a parking lot was constructed. In 1998, an estimated 5,000 to 10,000 thelypody plants were reduced to fewer than 300 plants due to additional disturbances that occurred at the rodeo. Most of the extant plants in the population now occur outside the rodeo grounds. It is possible that the thelypody population may recover from this disturbance, but it is not likely.

Recovery Measures – The thelypody recovery plan calls for the protection of five self-sustaining thelypody populations throughout its extant and historic range. Each of the five populations should have management plans providing for the plant's long-term protection and have stable or increasing trends for 10 years.

Currently, four populations of thelypody receive protection from development and are managed for conservation. The BLM has managed a population for several years until recently near North Powder on private land under a conservation easement. Three populations are managed by ODOT under a SMA (N. Testa, pers. comm. 2006). Another population near North Powder was leased by TNC for 15 years, but lease negotiations were not renewed.

The Service has funded the ODA to develop cultivation and out-planting methods for several years and in the process several populations have been re-introduced.

2. **MacFarlane's Four-O'clock (*Mirabilis macfarlanei*)**
Listing Status and Description – MacFarlane's Four-O'clock was first listed as endangered in 1979, and was reclassified to threatened in 1996 due to improvement in the status of the species and discovery of additional populations

(USDI 1996b). Federal listing did not include critical habitat. A recovery plan was completed for the species in 1985 and updated in 2000.

Macfarlane's four-o'clock is a member of the four-o'clock family (Nyctinaceae). It was first described in 1936 from specimens collected along the Snake River (Service 2000). Macfarlane's four-o'clock is a long-lived herbaceous perennial with a thickened taproot that is very deep in relation to the above ground portion of the plant. This species typically blooms from May through June. The bright pink flowers are conspicuous, up to one inch long by one inch wide. The flowers occur in inflorescences, consisting of a group of three to seven flowers subtended by a five-lobed involucre (saucer-shaped bract). Each flower has the potential to produce one fruit and one seed (USFWS 2000). The flowers are funnel-shaped with a widely expanding limb. Leaves are opposite, somewhat succulent, and broadly lanceolate (spear-shaped) to ovate (egg-shaped) (USFWS 2000). Individual stems have been observed to live over 20 years. Seeds are typically dispersed in June and July, and seed germination probably occurs in early spring. Seed germination and establishment may be infrequent and may be dependent upon a specific suite of environmental conditions (USFWS 2000). In addition to reproducing by seed, plants reproduce clonally from a thick, woody tuber that sends out many shoots.

Population Trends and Distribution – MacFarlane's Four-o'clock (*Mirabilis macfarlanei*) is endemic to portions of the Snake, Salmon, and Imnaha river canyons in west-central Idaho and adjacent northeastern Oregon, an area approximately 29 miles (47 km) by 18 miles (29 km). The population in the Snake River Unit occurs on Wallowa-Whitman National Forest lands, with the majority of the plants in the Hells Canyon National Recreation Area. It is currently found in 13 Element Occurrences (EOs) in Idaho and Oregon (2 in the Imnaha, 3 in the Snake, and 8 in the Salmon drainages). [An Element Occurrence (EO) is an area of land and/or water in which a species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location (USFWS 2008). The population size for all Macfarlane's four-o'clock populations in Idaho and Oregon was previously considered to range from 1,500 to 3,000 individuals (7,500 to 15,000 stems), based on estimates of clonal size (USFWS 2000) and on population estimates for Macfarlane's four-o'clock sites in Idaho and Oregon (USFWS 2000). However, recent information and survey data suggest that the total population size for this species is approximately 8,000 to 9,000 individuals (39,000 to 44,000 stems) (USFWS 2000).

There are approximately 6,000 plants, twelve occurrence site locations of the plant on the Wallowa-Whitman National Forest (in the action area), 325 known acres; and there is a 39,090 acres of modeled potential habitat in the Hells Canyon National Recreation Area (HCNRA) of the forest.

Reasons for Decline – The Revised Recovery Plan for Macfarlane's four-o'clock (USFWS 2000) extensively discusses the reasons for Federal Listing and the threats to this species. The invasion of non-native plant species and the effects of wildfire continue to be the two main threats to Macfarlane's four-o'clock and its habitat. At least six of the known 13 Macfarlane's four-o'clock EOs have burned since 1990 and one or more species of invasive non-native plants, such as cheatgrass (*Bromus tectorum*), yellow starthistle (*Centaurea solsitialis*), and dalmation toadflax (*Linaria dalmatica*), have been documented at all Idaho EOs. Other notable potential threats to this species include tramping and grazing by both native herbivores and domestic livestock, herbicide and pesticide spraying, and recreation and off-highway vehicles (OHVs) (USFWS 2009).

Recovery Measures – Recovery actions that have occurred to data include; 1) Establishment of an interagency technical work group, 2)Surveys for this species on the Wallowa-Whitman National Forest within the Hells Canyon National Recreation Area from 2006 to present, 3)Development and Implementation of a range-wide monitoring strategy (Mancuso 2011), 4) Survey and treatment of invasive non-native weeds, and 5)Planning for the reintroduction of Macfarlane's four-o'clock through seed collection, storage, and propagation (Berry Botanical Garden).

5. Spalding's Catchfly (*Silene spaldingii*)

Listing Status and Description – Spalding's Catchfly was listed as threatened in October 2001 (USFWS 2001). Designation of critical habitat was determined to be prudent; however, it will not be designated until available resources and priorities allow (66 FR 51598, USFWS 2001). The recovery plan was finalized on September 6, 2007 (USFWS 2007).

It is a regional endemic found predominantly in bunchgrass grasslands and sagebrush-steppe, and occasionally in open pine communities, in eastern Washington, northeastern Oregon, west-central Idaho, western Montana, and barely extending into British Columbia, Canada.

Spalding's catchfly (Silene spaldingii) is an herbaceous perennial plant, a plant that withers to the ground every fall and emerges again in spring. Spalding's catchfly is a member of the pink or carnation family, the Caryophyllaceae. It was first collected by Henry Spalding around 1846 near the Clearwater River in Idaho and later described by Sereno Watson in 1875, based on the Spalding material (USFWS 2007). The species has no other scientific synonyms nor has its taxonomy been questioned. Plants range from 20 to 61 centimeters (8 to 24 inches) in height, occasionally up to 76 centimeters (30 inches). There is generally one light-green stem per plant, but sometimes there may be multiple stems. Each stem bears four to seven pairs of leaves that are 5 to 8 centimeters (2 to 3 inches) in length, and has swollen nodes where the leaves are attached to the stem. All green portions of the plant (leaves, stems, calyx [defined below]) are covered in dense sticky hairs that frequently trap dust and insects, hence the common name "catchfly." The plant has a persistent root crown atop a long taproot (1 meter [3 feet]) in length. Typically, Spalding's catchfly blooms from mid-July through August, but it can bloom into September.

Three to 20 (up to 60) flowers are horizontally positioned near the top of the plant in a branched arrangement (inflorescence). Flowers are approximately 1 centimeter (0.5 inch) long; however, the majority of the flower petal is enclosed within a leaf like tube, the calyx, that resembles green material elsewhere on the plant and has 10 veins running from the flower mouth to the base of the flower. The visible portion of the five flower petals is small (2 millimeters [0.08 inch]), cream-colored, and extends only slightly beyond the calyx. Below the visible flower petals (blades) are four to six very small (0.5 millimeter [0.02 inch]) appendages, the same color as the blades. Seeds are small (2 millimeters [0.08 inch]), wrinkled, flattened, winged, and light brown when mature (USFWS 2007).

Population Trends and Distribution –
There are currently 99 known populations of Spalding's catchfly, with two thirds of these (66 populations) composed of fewer than 100 individuals each. There are an additional 23 populations with at least 100 or more individuals a piece, and the ten largest are each made up of more than 500 plants. Additional plants are continuing to be found, therefore, these numbers are likely to change with additional surveys. The recovery plan describes occupied habitat within five physiographic regions; 1) the Palouse Grasslands in west-central Idaho and southeastern Washington; 2) the Channeled Scablands in eastern Washington; 3) the Blue Mountain Basins in northeastern Oregon; 4) the Canyon Grasslands of the snake river and its tributaries in Idaho, Oregon, and Washington; and 5)the Intermontane Valleys of northwestern Montana.

This species occurs on the Umatilla National Forest and Wallowa-Whitman National Forest in Washington and Oregon (in the action area). There is one population and 12 site locations of this species on the Umatilla National Forest to date, and there are three populations and eleven occurrence site locations on the Wallowa-Whitman National Forest for 43.1 acres.

Reasons for Decline – The Recovery Plan for Spalding's catchfly (USFWS 2007) discuss the reasons for Federal Listing, and the threats to this species. A summary of the threats from the Recovery Plan are provided here. The effects of invasive nonnative plants, problems associated with small, geographically isolated populations, changes in the fire regime and fire effects, land conversion associated with urban and agricultural development, adverse livestock grazing and trampling, herbicide and insecticide spraying, adverse grazing (herbivory) and trampling by wildlife species, off-road vehicle use, insect damage and disease, impacts from prolonged drought and climate change, and inadequacy of existing regulatory mechanisms have been implicated as current threats and reasons for the decline of Spalding's catchfly.

Recovery Measures – Surveys and invasive plant inventories at Deadhorse Ridge on the Wallowa-Whitman National Forest located new populations. This is within the Blue Mountains Basin. Plant surveys performed as part of the Lower Imnaha Allotments analysis on the Wallowa-Whitman National Forest located a new population of approximately 300 Spalding's catchfly plants (within the canyon grasslands). BLM located its first population in Oregon in 2011, within the canyon grasslands on a ridge near the Grande Ronde River (Redmond Grade). Approximately 22 plants were documented at this new Oregon BLM site; habitat is good so there is potential for more plants. The Umatilla National Forest to date is conducting a fire treatment monitoring program and is finding new occurrences (potentially subpopulations). Draft consistent range-wide long-term monitoring methods for Spalding's catchfly developed and presented to technical team in 2012.

6. Ute Ladies'- Tresses (*Spiranthes diluvialis*)

Listing Status and Description – *Spiranthes diluvialis* was federally listed as threatened in 1992 (USDI 1992c) when it was only known from Colorado, Utah, and Nevada. *Spiranthes diluvialis* is a perennial, terrestrial orchid that is endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams (USFWS 1995). The species is found in a variety of soil types ranging from fine silt/sand to gravels and cobbles, and has also been found in highly organic or peaty soils. The species has not been found in heavy or tight clay soils or in extremely saline or alkaline soils (pH>8.0) (USFWS 1995). It is generally intolerant of shade, preferring open grass and forb-dominated sites.

Population Trends and Distribution – *Spiranthes diluvialis* has been found in Wyoming, Montana, Nebraska, Idaho and Washington. The species is located in Okanogan and Chelan Counties in Washington State, but has not been documented on federal land, although it is suspected to occur on the Okanogan-Wenatchee NF, and also on the Wallowa-Whitman NF in Oregon.

Reasons for Decline – The main threat factors cited for listing were loss and modification of habitat and the hydrological conditions of existing and potential habitat. The orchid's pattern of distribution in small, scattered groups, restricted habitat, and low reproductive rate under natural conditions make it vulnerable to both natural and human-caused disturbances.

Recovery Measures – A draft recovery plan for *Spiranthes diluvialis* was developed by the US Fish and Wildlife Service (1995), but has not been finalized. This plan had three primary objectives for achieving recovery:

1. Obtaining information on life history, demographics, habitat requirements, and watershed processes that will allow specification of management and population goals and monitoring progress 2. Managing watersheds to perpetuate or enhance viable populations of the orchid
3. Protecting and managing Ute ladies'-tresses populations in wet meadow, seep, and spring habitats.

The draft recovery plan identified several action items needed to achieve these objectives. To date, progress has been made on elucidating the life history, demography, pollination biology, genetic structure, and habitat dynamics of

Spiranthes diluvialis (USFWS 2005). Baseline inventories have been completed for sites in Colorado, Utah, and Wyoming that were not known when the plan was drafted and for new occurrences discovered since 1995 in Idaho, Montana, Nebraska, and Washington. The known habitat of *Spiranthes diluvialis* has broadened with the discovery of riverine populations in Utah, Idaho, and Washington, as has the need to expand conservation targets in objective 3. Less progress has been made on defining conservation units by watershed, developing watershed-based recovery goals, and informing the public about the merits of the watershed approach. Additionally, trend data and basic monitoring information are not available for nearly 75% of all known occurrences, making it difficult to identify management needs and develop conservation priorities. Active or partially active management actions involving monitoring, habitat manipulation, and other actions specifically intended to promote *Spiranthes diluvialis* recovery have been initiated for 12 of 52 extant populations (23%). Eighteen extant populations (34.6%) are now under some form of protection through special management area designation, conservation easements, or management agreements with the Army Corps of Engineers. (USFWS 2005).

7. **Water Howellia (*Howellia aquatilis*)**

Listing Status and Description – *Howellia aquatilis*, a wetland plant, was listed as a threatened species in July 1994 (USDI 1994b). *Howellia aquatilis* is an aquatic annual plant that is restricted to small vernal, freshwater, ephemeral wetlands which have an annual cycle of filling up with water over the fall, winter and early spring, followed by drying during the summer months. The species grows in firm consolidated clay and organic sediments that occur in wetlands associated with ephemeral glacial pothole ponds and former river oxbows. The plant's microhabitats include shallow water and the edges of deep ponds that are partially surrounded by deciduous trees.

Population Trends and Distribution – The historic range of this species included California, Idaho, Montana, Oregon and Washington, but the range has subsequently been reduced to Idaho, Montana and Washington (USDI 1994b). It has been reported from Clackamas, Marion, and Multnomah Counties in Oregon, and from Mason, Thurston, Clark and Spokane Counties in Washington. It is believed to have been extirpated from California and Oregon, and from Mason and Thurston Counties in Washington. Extant populations occur in Washington in Spokane and Clark Counties. The species has not been documented on any Forest included in this BA, but is suspected based on presence of potential habitat on the Gifford Pinchot and Okanogan-Wenatchee NFs.

Reasons for Decline – *Howellia aquatilis* has narrow ecological requirements and subtle changes in its habitat could affect a population. Threats to the populations include loss of wetland habitat and habitat changes due to timber harvest and road building, livestock grazing, residential and agricultural development, alteration of the surface or subsurface hydrology, and competition from introduced plant species such as reed canary grass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*) (USDI 1994b).

Recovery Measures – None to date.

8. **Wenatchee Mountains Checker-Mallow (*Sidalcea oregana* var. *calva*)**

Listing Status and Description – The Wenatchee Mountains Checker-Mallow was federally listed as endangered in 1999. Critical habitat was designated in 2001 (USDI 2001a). *Sidalcea oregana* var. *calva* is a perennial plant with a stout taproot that branches at the root crown and gives rise to several stems that are 20 to 150 centimeters in length. Pink flowers begin to appear in middle June and peaks in the middle to end of July. Fruits are ripe by August (USDI 1999c).

Population Trends and Distribution – Although the species *Sidalcea oregana* (Oregon checker-mallow) occurs throughout the western United States, *S. oregana* var. *calva* is known only to occur at six sites (populations) in the mid-elevation wetlands and moist meadows of the Wenatchee Mountains in central Washington state (USDI 2001a). The only unit included in this BA where the species has been documented is the Okanogan-Wenatchee NF. *Sidalcea oregana* var. calva is most abundant in moist meadows that have surface water or saturated upper soil profiles during spring and early summer. It may also occur in open conifer stands dominated by ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) and on the margins of shrub and hardwood thickets. Populations are found at elevations ranging from 1,900 to 4,000 feet. Soils are typically clay-loam and silt-loams with low moisture permeability.

Reasons for Decline – The primary threats to this species include alterations of hydrology, rural residential development and associated activities, competition from native and alien plants, recreation, fire suppression, and activities associated with fire suppression. To a lesser extent threats include livestock grazing, road construction, and timber harvesting and associated impacts including changes in surface-runoff in the small watersheds in which the plant occurs (USDI 1999c).

Recovery Measures – The area designated as critical habitat for the Wenatchee Mountains Checker-Mallow includes all of the lands that have the primary constituent elements below 1,000 m (3,300 ft) within the Camas Creek watershed and in the small tributary within Pendleton Canyon before its confluence with Peshastin Creek, and includes: (1) The entire area encompassed by the Camas Meadow Natural Area Preserve, which is administered by the WDNR; (2) two populations located on Forest Service land; (3) the small drainage north of the Camas Land, administered by the WDNR; (4) the population on private property located in Pendleton Canyon; and (5) the wetland complex of these watersheds necessary for providing the essential habitat components on which recovery and conservation of the species depends (USDI 2001a). Portions of the designated critical habitat are presumably unoccupied by *Sidalcea oregana* var. *calva* at present, although the entire area has not been recently surveyed. Soil maps indicate that the entire area provides suitable habitat for the species, and there may be additional, but currently unknown, populations present (USDI 2001a).

9. Rough Popcornflower (*Plagiobothrys hirtus*)

Listing Status and Description –The rough popcornflower was federally listed as endangered in January, 2000. This species is also on the state of Oregon's State Endangered Plant list. A recovery plan was published for the species on July 28, 2003 (USDI 2003a).

Rough popcornflower can be a perennial, growing to 70 cm tall, with dozens of flowering stems and hundreds of flowers, or can be a diminutive annual with only a few flowers (Amsberry 2001). At Popcorn Swale Preserve, rough popcornflower generally reaches peak growth and flowering by mid-June. By July 1, many plants have dropped seed and are senescing. By July 15, rough popcornflower generally appears gray-brown and crispy although a rare flower or two may be found low to the ground in moister, shaded areas. Although most plants are dormant by mid-July, perhaps around one percent of individuals may still be green and actively growing and flowering.

Rough popcornflower, like most borages, can potentially produce four nutlets per flower. In most sites, copious numbers of mature seeds were observed from mid-June through early September, but plants in a few wetter habitats delayed seed maturation until the beginning of August. The number of seeds produced by individual plants is largely controlled by the number of flowers produced, and correspondingly, large plants produce more flowers.

This herb is endemic to seasonal wetlands in the interior valley of the Umpqua River in southwestern Oregon between Yoncalla and Wilbur, Oregon. Known occurrences for the plant are associated with Calapooya, Sutherlin, and Yoncalla creek drainage systems in Douglas County. Rough popcornflower habitat has been characterized as open seasonal wetlands at elevations ranging from 30 to 270 m (98 to 886 ft). Populations are known to occur on six different soil types (Conser silty clay loam, Bashaw silty clay loam, Brand silty clay loam, , Nonpareil loam, Oakland silt loam, and Sibold fine sandy loam) but there is a positive correlation only for Conser silty clay loam (USDI 2000a). Seasonal flooding and fire are natural ecological functions considered necessary for long term population viability of the plant. These processes maintain the open habitat upon which the species is dependent and limit competition from invasive native and non-native species.

The wetland plant community at rough popcornflower habitats may include red-root yampa, a federal species of concern, great camas (*Camassia leichtlinii* var. *leichtlinii*), Douglas meadowfoam (*Limnanthes douglasii*), California oatgrass, one-sided sedge (*Carex unilateralis*), pointed rush (*Juncus oxymeris*), meadow barley (*Hordeum brachyantherum*), and Cusick's checkermallow (*Sidalcea cusickii*). Bottomland riparian ash woodland along Sutherlin, Calapooya, and Yoncalla creeks provides cover for abundant Columbia white-tail deer (*Odocoileus virginianus leucurus*).

Population Trends and Distribution – Rough popcornflower occurs in only 17 isolated patches of habitat in the vicinity of Sutherlin and Yoncalla, Douglas County, Oregon (Table 1). A total of 20,147 plants are estimated to occur on approximately 16 ha (40 ac). Fifteen of the 17 patches are on private or commercial land, including three patches managed by The Nature Conservancy. Two patches occur on state land managed by ODOT and are conserved under State law. The Nature Conservancy, ODOT, and ODA Plant Conservation Program have initiated monitoring, life history studies, and transplantation experiments with the objective to increase population sizes on habitat patches. Two additional populations have been introduced on the Roseburg District, BLM lands. Monitoring and enhancement is on-going for these populations. The BLM intends to introduce at least one more population of rough popcornflower within suitable habitat. These introduced populations will need to persist for at least five years before they will be considered successfully established.

Reasons for Decline – Most of the mapped historic occurrences of the species have been destroyed or deteriorated by development in the vicinity of the town of Sutherlin in the last twenty years. Habitat declines can be attributed to the following: destruction of wetlands due to drainage for agricultural uses; pools adjacent to altered land may also be affected due to the changes in hydrology (USDI 2003b); wetland destruction due to urban development (USDI 2000a); heavy spring and summer grazing by cattle and sheep while limited grazing may help to control exotic weeds and remove thatch buildup (USDI 2000a); invasive exotic weeds such as teasel (*Dipsacus fullonum*), knapweed (*Centaurea sp*.), Eurasian blackberry (*Rubus discolor*), and pennyroyal (*Mentha pulegium*) (USDI 2000a); fire suppression resulting in encroaching native oaks and ash trees which shade Plagiobothrys hirtus ssp. hirtus (USDI 2000a); reduced gene flow due to habitat fragmentation (USDI 2000a). Rough popcornflower is threatened by habitat loss or degradation, livestock grazing, and competition from native and non-native plant species.

Recovery Measures – Ten populations of rough popcornflower are currently protected from development. One 5,000 plant strong population is on land owned and managed by Douglas County Soil and Water Conservation District. Four occur on ODOT right-of-ways, one on an ODOT-owned mitigation property, and two occur on land managed by The Nature Conservancy at the Popcorn Swale Preserve. One population recently estimated to have nearly 3,000 plants, occurs on the City of Sutherlin's festival grounds. Three populations were introduced to Roseburg BLM. A recent inventory for new and known populations was conducted throughout the range in 2005 by ODA. Documentation of the distribution and abundance of rough popcornflower began in 1995 and has continued annually, except for 2001 for the TNC and the BLM populations. In June 2003, TNC counted 13,065 plants at Popcorn Swale Preserve, but by June 2012 the number was down to about 1,000 plants. The introduced Westgate population on BLM land has remained above 10,000 individuals since then (K. Amsberry, pers. comm. 2012).

10. Macdonald's Rockcress (*Arabis mcdonaldiana Eastwood)*

Listing Status and Description – McDonald's rock-cress was federally listed as endangered without critical habitat in 1978. A recovery plan was published for the California populations in 1990. *Arabis macdonaldiana* is one of several closely related endemic species (species restricted to a well-defined geographic area) which have evolved in the Siskiyou Mountains region of southwest Oregon and northwest California. This species was not discovered in Oregon until 1980.

Arabis macdonaldiana is s perennial species in the mustard family (*Brassicaceae*). This species has a branched caudex (short, vertical, often woody stem at or just beneath the ground surface) and several simple stems that measure 5-20 cm (2-8 in) in height. The lower leaves are in rosettes (a cluster of leaves in a circle), are spatulate (rounded above and narrowed to the base), measure 1-2 cm (0.4-0.8 in) long and 4-7 mm (0.2-0.3 in) wide, are toothed, and are essentially smooth. The petals are rose or purple in color and measure 9-11 mm (0.35-0.43 in) long. The fruits are siliques (elongate, dry, and open at maturity) that measure 3-4 cm (1.2-1.6 in) long. Flowering typically occurs from late April through June. This species is distinguished from other rock-cress species by being almost glabrous (without hairs or glands) and by possessing spatulate basal leaves 1-2 cm (0.4-0.8 in) long. *Arabis macdonaldiana* occurs on serpentine soils (high in magnesium, iron, and certain toxic metals). This species is found below 1500 m (4920 ft) elevation in dry, open woods or brushy slopes, with sanicles (*Sanicula spp.),* violets (*Viola spp*.), and onions (*Alium spp*.). It is an attractive plant, as are many of the endemic rock-cress species of the Siskiyou Mountains. Taxonomic studies are currently underway to investigate the relationship of the Oregon population to those in California.

Population Trends and Distribution – There have been various population monitoring studies for *Arabis macdonaldiana*. The species is restricted to Red Mountain in Mendocino County, California, on U.S. Forest Service and private land (High Siskiyous), in adjacent Del Norte County, California (North Smith River), and in Curry County in Oregon. The population periodically trends up and down depending on weather patterns, degree of vegetation succession, and human-caused disturbance.

Reasons for Decline – Mining activities, vegetation succession, and human-caused disturbance have contributed to the decline of this species.

Recovery Measures – The results of a genetics study that will soon be completed will elucidate, at a minimum, the relationship between the Red Mountain, North Fork of the Smith River, and High Siskiyou populations. If the current taxonomy is determined to be justified based on genetic considerations, a downgrade in status would be considered. However, if the genetics study indicates the Red Mountain population is the sole population of *A. macdonaldiana*, then an assessment should be conducted of the current threats to that population, and whether it warrants continued protection under the ESA.

11. Gentner's fritillary (*Fritillaria gentneri*)

Listing Status and Description – *Fritillaria gentneri* was federally listed as endangered on December 10, 1999 (64 FR 237) without critical habitat designation. The species is also on the State of Oregon's State Endangered Plant list. A recovery plan for the species was published on July 21, 2003. ***Fritillaria gentneri*** is a perennial herb arising from a fleshy bulb producing numerous small rice-grained bulblets. The plant also produces several large scales surrounded by 10 to 150 small rice-grained bulblets per plant (USFWS 2003b). ***Fritillaria gentneri*** forms large maroon to bright reddish flowers with yellow mottles that are easily observed in the early spring. The flowers are solitary, or in bracted racemes, 1 to 7 (rarely more) on long slender pedicels. The 2.5 to 4.0 cm bell-shaped flower has segments that bend more or less outward, at times straight, but are not strongly recurved like the common scarlet fritillary (*Fritillaria recurva*).

Fritillaria gentneri emerges from the ground in early February, flowers from mid-April to early June, and is dormant from mid-August to mid-January. Non-flowering fritillaries greatly outnumber flowering plants in natural populations, and are recognizable only by their single ovate to lanceolate basal leaf, indistinguishable from several other common related fritillaries. Due to poor and erratic seed production, bulblet production and disbursement are the principal means of Gentner's fritillary propagation.

Recent research (Amsberry and Meinke 2002) has documented erratic and extremely low seed production in the species. This research has indicated that the plant is largely reproducing asexually. Pollination studies by the ODA and Oregon State University (Amsberry and Meinke, 2002) conducted in the Jacksonville Woodlands and the Jacksonville Cemetery did not produce a single viable seed.

A population of fritillaries consists of plants at three different life stages: flowering plants, vegetative mature plants, and vegetative juvenile plants. Using data provided by Brock and Knapp (2000), it is estimated that each flowering fritillary located in a population represents an estimated 40 plants from all three life stages.

Fritillaria gentneri occurs in a variety of habitats including oak woodlands dominated by Oregon white oak (*Quercus garryana*), mixed hardwood forest dominated by California black oak (*Quercus kelloggii*), Oregon white oak, and madrone (*Arbutus menziesii*), and coniferous forests dominated by madrone and Douglas-fir (*Pseudotsuga menziesii*). The 25 soil types that the plant has been known to occur on are Abegg, Beckman-Colestine complex, Brader-Debenger complex, Caris-offennbacher complex, Cornutt-Dubakelia complex, Dubakella-Pearsoll complex, Farva, Heppsie, Heppsie-McMullin complex, Holland, Langellain, Langellain-Brader complex, Manita, McNull-Medico complex, McMullin-Rockoutcrop complex, McNull, McNull-Medco complex, McNull-McMullin complex, Ruch, Tallowbox, Tatouche, Vannoy, Vannoy-Voorhies complex, Woodseye-rockoutcrop complex and Xerothents-Dumps complex

(USDI 2003). The soil types most commonly supporting the plant are Vannoy and Vannoy-Voorhies complex.

Population Trends and Distribution – There are approximately 90 populations of ***Fritillaria gentneri***. The largest single documented occurrence to date for ***F. gentneri*** (Pilot Rock Lower, Cascade Siskiyou National Monument, Medford District BLM) contained 600 flowering plants in 2004. The larges area occupied by ***Fritillaria gentneri*** is at the Jacksonville Woodlands with plants distributed sparsely over approximately 100 acres. The smallest population known is one plant. A total of 1952 flowering plants were observed on BLM lands in 2004. Seven new populations were found during the field season of 2003 on Medford BLM lands. Currently perilously small, widely scattered populations with one to five flowering adult each comprise an estimated 80 percent of the entire population.

Fritillaria gentneri occurs in Jackson and Josephine counties in Oregon and in northern Siskiyou County in California and is often associated with open oak woodlands. The range of this species extends from just below the California border in Siskiyou County to Applegate Lake and Pilot Rock north to the communities of Butte Falls, Sunny Valley, and Galice. Most known sites on federal land occur near the communities of Jacksonville, Ruch, Rogue River, Gold Hill, Sam's Valley, Grants Pass, and Merlin. Large areas of suitable habitat on private lands within the range have not been surveyed and may be occupied.

Reasons for Decline – Habitat loss is the main threat to this species. Habitat loss due to ongoing or future development may occur at 42 percent of the known occupied sites (64 FR 237, 1999). ***Fritillaria gentneri*** populations are often directly impacted by development in the form of housing construction, cemetery expansion, trail maintenance, road widening, landfill expansion, power line maintenance, water system construction, and agricultural conversions (64 FR 237, 1999). These activities primarily occur on private lands. Between 1941 and the present, the plant has been extirpated from eight of 114 known populations due to developmental expansion.

Recreational collection of plants could adversely affect the species, especially along roads, where the plant is more observable and most vulnerable. Because the species occurs in small, isolated clusters, an entire patch could be decimated in one gathering, extirpating the plant from that area.

Fritillaries appear to be a strongly preferred food choice by deer, which go to great lengths to eat flower stalks. Predation could conceivably reduce plant numbers and productivity. Many plant flowers are browsed before producing mature fruit. Many of the plants that were tagged for seed collection by Wayne Rolle, in 1988, had the capsules eaten by wildlife before the seed capsules matured (64 FR 237, 1999). Since the species does not appear to produce viable seeds, floral and/or upper stem herbivory may yield little impact. Intensive grazing (including trampling) by livestock at some sites may pose a much greater threat than browsing by deer (USFWS 2003b).

Private land owners are not required to protect State or federally listed plant species, except where projects are associated with federal funds or permits. As a result the plant receives nearly no protection from its State or federal status as endangered on private lands.

Fire exclusion has altered suitable habitat for the plant by permitting open oak woodland habitats to become more thickly wooded and less grassy. This transition can result in partial to total exclusion of plants. At the same time, the increase of homes in the area makes prescribed burning difficult. This has reduced suitable habitat for the plant while a less-than-optimal habitat condition is achieved that is also susceptible to catastrophic fire.

Of 40 monitored plant populations in 2003 by BLM contracts, 36 have less than 100 flowering individuals and 23 have zero to two flowering plants. The threat of extinction due to naturally occurring demographic and environmental events reduces the viability of the species as a whole. Because most plant sites occupy small areas, naturally occurring environmental events could also play a role in extirpation. Small clusters can disappear with one environmental event, such as erosion. ***Fritillaria gentneri*** sites are small and isolated from each other due to habitat fragmentation. This isolation could inhibit re-colonization to other suitable areas and could result in a permanent loss of localized occurrences once they fall below a critical level.

Recovery Measures –Most ***Fritillaria gentneri*** populations occur on Federal lands and are protected from development. The Medford BLM manages the majority of known ***Fritillaria gentneri*** sites by performing annual monitoring, funding research to determine life history dynamics and funds recovery actions such as habitat restoration and population augmentation. All ground disturbing activities that are carried out or permitted on BLM lands are surveyed for ***Fritillaria gentneri***. The BLM will protect or conserve any listed plants that are located on BLM administered land.

ODOT also manages two ***Fritillaria gentneri*** site on highway right-of-ways and has designated Special Management Areas (SMA) at the two locations. Management under the SMAs calls for annual or biennial monitoring and suspension of spraying, ditching, disking, or mowing activities to conserve the populations. ODOT also surveys suitable habitat for ***Fritillaria gentneri*** for presence of new populations prior to ground disturbing activities.

The City of Jacksonville has developed a management plan to address restoration of a ***Fritillaria gentneri*** population due to accidental construction of a road through the middle of a populations and subsequent infestation of the noxious weed, *Centaurea solstitialis* (yellow star thistle). Currently the yellow starthistle is nearly under control and the population is being carefully monitored.

12. **Nelson’s checkermallow (*Sidalcea nelsoniana*)**

Listing Status and Description – Nelson's checkermallow was listed as Threatended on February 12, 1993 (58 FR 8242) without designated critical habitat. This species is also on the state of Oregon’s State Threatened Plant list. A recovery plan for the species was finalized on May 20, 2010.

Nelson's checkermallow is a perennial herb in the mallow family (*Malvaceae*). It has tall, lavender to deep pink flowers that are borne in somewhat open clusters 50 - 150 cm (19.2 – 48 in) tall at the end of short stalks. Plants are partially dioecious, in that they have either perfect flowers (male and female) or pistillate flowers (female only). The plant can reproduce vegetatively, by rhizomes, and by seeds, which drop near the parent plant. Flowering typically occurs from late May to mid-July, but may extend into September in the Willamette Valley. Fruits have been observed as early as mid-June and as late as mid-October. Coast Range populations generally flower later and produce seed earlier, probably because of the shorter growing season. Seed production for a Nelson’s checkermallow plant is typically high. An average plant may produce between 300 and 3000 seeds, but could potentially exceed 10,000 seed. The limiting factor of Nelson’s checkermallow seed production is weevil damage. Weevils typically associated with the plants in the wild often infest flowers and eat flowers. Early in seed production, weevils often consume developing embryos and may account for 80 percent to 100 percent loss of pre-dispersal seed.

Population Trends and Distribution – Nelson’s checkermallow primarily occurs in Oregon’s Willamette Valley, but is also found at several sites in Oregon’s Coast Range and at two sites in the Puget Trough of southwestern Washington. The plant’s range extends from southern Benton County, Oregon, north to Cowlitz County, Washington, and from central Linn County, Oregon, west to the crest of the Coast Range. The species is known to occur in 65 occurrences within five relict population centers in Oregon and Washington and occupy approximately 273 acres (110 hectares) (USDI 1998a).

Reasons for Decline – A serious long-term threat to all Willamette Valley prairie species is the change in community structure due to plant succession. The vast majority of Willamette Valley prairies would likely be forested if left undisturbed. The natural transition of prairie to forest in the absence of disturbance such as fire will lead to the eventual loss of these prairie sites unless they are actively managed (Franklin and Dyrness 1973, Johannessen et al. 1971; Kuykendall and Kaye 1993).

Habitats occupied by Nelson’s checker-mallow contain native grassland species and numerous introduced taxa. In some areas, habitats occupied by Nelson’s checker-mallow are undergoing an active transition towards a later seral stage of vegetative development, often due to the encroachment of non-native, invasive species (i.e., , brush competition). Invasive woody species of concern include non-native plants such as Himalayan blackberry (*Rubus discolor*), multiflora rose

(*Rosa multiflora*), European hawthorn (*Crataegus monogyna*), and Scotch broom (*Cytisus scoparius*). Invasive native species include Oregon ash, Douglas hawthorn (*Crataegus douglasii*), Nootka rose (*Rosa nutkana*) and Douglas spiraea (*Spiraea douglasii*).

Due to this rapid invasion by woody vegetation (especially Scotch broom) in some areas and the suppression of natural fire regimes, secondary successional pressures on these plant populations are expected to increase over time. Habitat conversion via succession and/or agricultural activities poses measurable threats to the long-term stability of Nelson's checker-mallow populations.

Agricultural and urban development have modified and destroyed habitats, fragmenting populations into small, widely scattered patches. In the Willamette Valley, extirpation is an ongoing threat to many Nelson's checker-mallow occurrences on private lands, roadsides, and undeveloped lots zoned for industrial and residential development. Within the genus Sidalcea, the actual sex ratio (the number of functionally pistellate to perfect flowers) of a population may be a strong contributing factor to its genetic vigor or vulnerability such that the ratio of pistellate to perfect flowers may ultimately control the amount and quality of seeds produced regardless of habitat quality. Likewise, seed predation by weevils prior to seed dispersal may also be a factor controlling seed production.

Prior to European colonization of the Willamette Valley, naturally occurring fires and fires set by Native Americans maintained suitable Nelson's checkermallow habitat. Current fire suppression practices allow succession of trees and shrubs in Nelson's checkermallow habitat. Remnant prairie patches in the Willamette Valley have been modified by livestock grazing, fire suppression, or agricultural land conversion. Stream channel alterations, such as straightening, splash dam installation, and rip-rapping cause accelerated drainage and reduce the amount of water that is diverted naturally into adjacent meadow areas. As a result, areas that would support Nelson's checkermallow are lost.

The most serious management threat related to and land use faced by the 29 populations on private lands which are not subject to state and federal laws governing listed plant species. Seventeen years of population observation has documented the ongoing disturbance or complete extirpation of populations on private land due to non-industrial timber harvest operations, development, herbicide application, agricultural activities, and other land-use practices (CH2M Hill 1996) Although numerous checkermallow occurrences are on public lands many are threatened by inadvertent disturbance from roadside maintenance, herbicide application and mowing, soil cultivation, ditching, and other habitat modification.

Recovery Measures – See *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf) for recovery goals, objectives, and criteria.

13. Western lily (*Lilium occidentale*)

Listing Status and Description –Western lily was listed as federally endangered on August 17, 1994 (59 FR 42176). Critical habitat has not been designated for the species. This species is also on the state of Oregon's State Endangered Plant list. A recovery plan for the species was published on March 31, 1998.

Western lily was first collected by Carl Purdy from headlands around Humboldt Bay, California. He subsequently described the plant in 1897. Western lily, an herbaceous perennial in the lily family (*Liliaceae*), grows from a short unbranched, rhizomatous bulb, reaching a height of up to 2.4 m (8 ft). Leaves grow along the stem singly or in whorls and are up to 19 cm (7.5 in) long and pointed. The nodding flowers are red, sometimes deep orange, with yellow to green centers in the shape of a star and spotted with purple. The six petals (tepals) are 3 to 4 cm (1 to 1.5 in) long and curve strongly backwards. Fruit capsules become erect and may produce over 100 seeds when mature. This species can be distinguished from similar native lilies by the combination of pendent red flowers with yellow to green centers in the shape of a star, highly reflexed petals, non-spreading stamens closely surrounding the pistil.

Like other lilies, the western lily has hermaphroditic flowers (producing both pollen and seeds). The plant reproduces primarily by seed, but asexual reproduction is possible from detached bulb scales growing into new plants. A bulb scale is formed in the fall, and the first true leaf emerges the following spring. In cultivation, lilies may take 4 to 5 years to flower for the first time (Schultz 1989), and may live for 25 years or more (Kline 1984). Populations of non-flowering lilies may persist for many years under closed forest canopies.

In nature, western lily shoots emerge from the ground anywhere from late March to late May, with emergence occurring generally two to three weeks later in the northern part of the range compared to farther south. From June to July, green buds turn red for 3 to 5 days, open over a period of 1 to 2 days, and the nodding flowers will last for 7 to 10 days. After the floral parts have fallen off, capsules enlarge to maturity over a period of 40 to 50 days. Seeds are primarily dispersed by wind and gravity, mostly within a 4-m (13-ft) radius. Usually in September, the above ground portion of the plants die back and individuals become dormant underground as rhizomes or bulbs. Dead, above-ground shoots may persist for one or more years in protected sites before they collapse and decompose. From late September to February plants are usually dormant.

Hummingbirds are the primary pollinator of the lily, but some bees and other insects may also occasionally transfer pollen (Skinner 1988; Schultz 1989). Low fruit set in isolated plants or those concealed in dense vegetation stresses the importance that the flowers are suitably presented to hummingbirds (Schultz 1989).

Juvenile plants are often observed near flowering adult lilies. In suitable habitat, there are often more juvenile plants than adult flowering plants. At some sites, particularly the sites with more than 200 plants, the majority of plants were non-flowering, which is probably an indication of stress (Schultz 1989).

Genetic differentiation is highly probable in lily populations. Throughout the range of the lily, populations are often small and liable to be subject to random genetic drift, are geographically isolated, occur in areas with unique soil development and microclimates, and have observable differences in morphologic traits (Schultz 1989). These factors indicate a significant degree of genetic differentiation in the species across its range.

Lily populations appear to have been maintained in the past by occasional fires, at least at some sites in Oregon, and by grazing. Among the most serious current threats is loss of habitat due to ecological succession facilitated by aggressive fire exclusion and removal of grazing. What effects these vegetation changes have had on hydrological aspects of lily habitat, and vice versa, are not well understood.

The lily is found at the edges of sphagnum bogs, in forest or thicket openings along the margins of ephemeral ponds and small channels, coastal prairies, scrublands, and forest openings near the ocean where fog is common. Bogs where the plant is often found are composed of poorly drained, slightly acidic, highly organic soils, usually underlain by an iron pan, or poorly permeable clay layer.

Population Trends and Distribution – Western lily appears to be declining across much of its range (D. Imper, pers. comm. 2005). Of the 62 recorded historical lily populations, nearly half (29) of the sites appears to have been extirpated. Of the remaining 33 reported sites, five have not been surveyed recently and thus it is unknown if plants are still present. Only two sites have as many as 1,000 individuals, 14 sites have between 100 and 999, and 12 sites had 99 or fewer (D. Imper, pers. comm. 2005). Most locations of known lily occurrences and population counts are described in the western lily recovery plan (USDI 1998b). Several sites have been added and others updated since the recovery plan publication date, for example, since 1989, an estimated 1,000 to 2,000 flowering plants were discovered at a site near Crescent City, California, where none were previously known (D. Imper, pers. comm. 2005).

Western lily populations are found at low elevations, from almost sea level to about 100 m (328 ft) in elevation, and from ocean-facing bluffs to about 6 kilometers (4 miles) inland. The lily is distributed along the coast from Hauser, Coos County, Oregon to Loleta, Humboldt County, California. The Hauser Bog is the northernmost population of western lily and is part of Recovery Area 1 (USDI 1998b). The plant is currently known from 7 widely separated regions, and has been reported from 62 mostly small, isolated, densely clumped populations (D. Imper, pers. comm. 2005).

Reasons for Decline – The primary threat to the lily is human modification or destruction of habitat. The lily is limited to coastal habitat which is currently undergoing intense development pressure. The species' bog and coastal prairie/scrub habitat occurs on level marine terraces that are desirable for coastal development because of the gentle topography and proximity to the ocean.

From the 1940s to the present, conversion of bog habitat to cranberry farms, roads, and residential dwellings has eliminated suitable lily habitat as well as some populations of the plant in the area from Bandon south to Cape Blanco (Schultz 1989). In the Bandon area alone, 1,600 acres have been converted to cranberry farms, much of them in low depressions with Bandon Silty Loam soils, and therefore could be suitable for the western lily (Bandon, Oregon 2005). The largest known population and three smaller populations near Crescent City, California are currently threatened by habitat degradation due to watershed development. Other threats include forest succession and livestock grazing. These activities primarily occur on private lands. Clearing and draining along the Elk and Six Rivers for livestock grazing have eliminated many of the once numerous populations there. As recently as 1992, a lily population within the city of Brookings was inadvertently destroyed.

Recreational collection of lilies could adversely affect the species, especially along roads, where it is more observable and most vulnerable. Because the species occurs in small, isolated clusters, a collector could decimate an entire clump in one gathering, extirpating the plant from that area.

Years of fire exclusion have led to changes in lily habitat structure and composition. Fire exclusion has altered suitable habitat for the lily by permitting open coastal prairie and wetland habitats to become more thickly wooded. This transition can result in partial to total exclusion of lilies. Removal of livestock has had the same effects. At the same time, the increase of homes in the area makes prescribed burning difficult. This has removed suitable habitat for the lily and has simultaneously produced a less-than-optimal habitat condition that is also susceptible to catastrophic fire. Gorse is a highly fire prone and aggressive noxious weed, occurring in coastal habitat, that threatens not only to replace lily populations, but chemically and ecologically alter suitable habitat.

Although probably not as serious as other threats, grazing by vertebrates (elk, deer, voles, and domestic cattle) and invertebrates (beetle, moth, or butterfly larvae) has been documented for the lily. Of these grazers, deer may represent a major threat, at least in California. Even if not lethal, deer remove a considerable fraction of flowers and fruit, thus seriously reducing the reproductive output at many sites. Deer herbivory has occurred at nearly all sites, and has numerous times eliminated over half a population's annual seed production.

The threat of extinction due to naturally occurring demographic and environmental events reduces the viability of the species as a whole. Because most lily sites occupy small areas, naturally occurring environmental events could also play a role in extirpation. Small clusters can disappear with one environmental event, such as erosion. Many lily sites are small and isolated from each other due to habitat fragmentation. This isolation could inhibit re-colonization to other suitable areas and could result in a permanent loss of localized occurrences once they fall below a critical level.

Recovery Measures – In California, private individuals, in conjunction with Humboldt State University and the California Department of Fish and Game, have had a formal management plan in place since 1987 for the Table Bluff Ecological Reserve. Since that time, considerable work has been done to recover the lily at Table Bluff and an extensive yearly monitoring record has been generated at this site and three nearby sites (USDI 1998b). Various experimental habitat manipulations and monitoring are occurring in California at Table Bluff and in the vicinity of Humboldt Bay.

In Oregon, The Nature Conservancy has monitored and managed a small population at Bastendorff Bog since 1985. ODOT has also managed a population in their right-of-way near Hauser by improving habitat through vegetation control. Oregon Parks and Recreation Department has begun restoration of a lily population near Brookings, Curry County, by improving habitat through vegetation control. The Coos Bay BLM has updated a 1995 management plan that now includes provisions for the restoration of lily habitat at the New River ACEC that includes implementing conservation measures and public outreach activities as recommended in the 1998 lily recovery plan. The Coos Bay BLM also has funded a lily propagation study on the New River ACEC in conjunction with the Berry Botanic Garden (Guerrant pers. com. 2004).

14. Willamette Valley Daisy (*Erigeron decumbens var. decumbens*)

Listing Status and Species Description – The Willamette Valley daisy was listed as endangered, without critical habitat, on January 25, 2000 (USDI 2000b). This species is also on the state of Oregon's State Endangered Plant list. A recovery plan for the species was published on May 20, 2010. A critical habitat determination was proposed for the species on November 2, 2005 (USDI 2005).

The Willamette daisy is a taprooted perennial herb in the sunflower or daisy family (*Asteraceae*). It grows 1.5 to 6 cm (0.6 to 2.4 in) tall, with erect to sometimes prostrate stems at the base. The basal leaves often wither prior to flowering and are mostly linear, 5 to 12 cm (2 to 5 inches) long and 3 to 4 mm (0.1 to 0.2 inches) wide. Flowering stems produce two to five heads, each of which is daisy-like, with pinkish to pale blue ray flowers and yellow disk flowers. The morphologically similar Eaton's fleabane (*E. eatonii*) occurs east of the Cascade Mountains, while the sympatric species Hall's aster (*Aster hallii*) flowers later in the summer. In its vegetative state, the Willamette daisy can be confused with Hall's aster, but close examination reveals the reddish stems of Hall's aster in contrast to the green stems of the Willamette daisy (Clark et al. 1993).

The Willamette daisy typically flowers throughout June and July with pollination carried out by syphrid flies and solitary bees (Ingersoll *et al.* 1995). The daisy produces and subsequently disperses large quantities of wind-dispersed seed in July and August. The seeds of the daisy are achenes, like those of other Erigeron species, and have a number of small capillary bristles (the pappus) attached to the top, which allow them to be distributed by the wind. Due to the small size and number of these bristles, the seeds do not fly well in the wind, so seed distribution is quite restricted.

The Willamette daisy is capable of spreading vegetatively through rhizomes over very short distances of less than 10 cm (4 in) and is commonly found in large clumps scattered throughout a site (Clark et al. 1993).

Willamette daisy responds positively to late spring and early summer rains. Studies conducted at the Willow Creek Preserve indicate that not all individuals of the Willamette daisy bloom every year, and that some individuals may remain dormant for an entire growing season (Kagan and Yamamoto 1987).

Population Trends and Distribution – The Willamette daisy is endemic to the Willamette Valley of western Oregon. Herbarium specimens show a historical distribution of Willamette daisy throughout the Willamette Valley; frequent collections were made in the period between 1881 and 1934, yet no collections or observations were recorded from 1934 to 1980 (Clark et al. 1993). The species was rediscovered in 1980 in Lane County, Oregon, and has since been identified at 48 sites on 93.6 ac (37.9 ha).

Population size may fluctuate substantially from year to year. Monitoring at the Oxbow West site, near Eugene, found 2,299 Willamette daisy plants in 1999, 2,912 plants in 2000, and only 1,079 plants in 2001 (Kaye and Brandt 2005). The population at Baskett Butte declined to 48 percent of the original measured population between 1993 and 1999 (Clark 2000; Ingersoll et al. 1995). Detecting trends in Willamette daisy populations is complicated by the biology and phenology of the species. For instance, Kagan and Yamamoto (1987) found it difficult to determine survival and mortality between years because of irregular emergence and sporadic flowering from year to year. They suggested that some plants probably lie dormant during some years, as indicated by the sudden appearance of large plants where they were not previously recorded, and the disappearance and later re-emergence of large plants within monitoring plots. In addition, Clark *et al.* (1993) stated that non-reproductive individuals can be very difficult to find and monitor due to their inconspicuous nature, and that the definition of individuals can be complicated when flowering clumps overlap.

The Willamette daisy is primarily found in wet prairie grasslands, but is also found at a few drier upland prairie sites. The wet prairie grassland community, which was historically maintained by periodic flooding and fires, is characterized by the dominance of tufted-hairgrass, California oatgrass, and a number of Willamette Valley endemic forbs.

Reasons for Decline – Like many native species endemic to Willamette Valley prairies, the Willamette daisy is threatened by habitat loss due to urban and agricultural development, secondary successional encroachment of habitat by trees and brush, competition with non-native weeds, and small population sizes (Kagan and Yamamoto 1987, Clark et al. 1993). The Fish and Wildlife Service (USDI 2000b) estimated that habitat loss is occurring at 80 percent of remaining 84 remnants of native prairies occupied by Willamette daisy and Kincaid's lupine. The Fish and Wildlife Service (USDI 2000b) also stated that 24 of the 28 extant Willamette daisy populations occur on private lands and, "without further action, are expected to be lost in the near future". Although populations occurring on private lands are the most vulnerable to threats of development (state and federal plant protection laws do not apply to private lands), publicly owned populations are not immune from other important limitations to the species. For instance, Clark et al. (1993) identified four populations protected from development on public lands (Willow Creek, Basket Slough NWR, Bald Hill Park, and Fisher Butte Research Natural Area), but stated that even these appear to be threatened by the proliferation of non-native weeds and successional encroachment of brush and trees. Likewise, vulnerability arising from small population sizes and inbreeding depression may be a concern for the species, regardless of land ownership, especially among 17 of the 28 remaining sites that are smaller than 8 ac (3.5 ha) (USDI 2000b). Given the predominance of privately-owned populations, land ownership represents a serious obstacle to conservation and recovery of Willamette daisy.

Recovery Measures – See *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington*: http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf) for recovery goals, objectives, and criteria.

Extensive research has been conducted on the ecology and population biology of the Willamette daisy, effective methods for habitat enhancement, and propagation and reintroduction techniques (Clark et al. 1995;, Ingersoll et al. 1995; Clark et al. 1997; Clark 2000; Leininger 2001; Kaye et al. 2003). The results of these studies have been used to direct the management of Willamette daisy populations at Baskett Slough NWR, Eugene BLM, and Willamette Valley TNC preserves.

Several studies have investigated the feasibility of growing Willamette daisy in controlled environments for augmentation of wild populations. Cold stratification or seed-coat scarification is necessary for successful germination (Clark et al. 1995; Kaye and Kuykendall 2001b). Stem and rhizome cuttings have also been used successfully to establish plants in the greenhouse (Clark et al. 1995). Attempts to establish Willamette daisy at new sites has shown that transplanting cultivated plants is much more effective than sowing seeds directly.

The Fish and Wildlife Service's Partners for Wildlife Program works with private landowners to restore and conserve wildlife habitat. During the 2004 fiscal year, the Partners program worked on eight projects in Benton and Marion Counties, Oregon that restored 340 ac (137.6 ha) of wet prairie, oak savannah and upland prairie habitats, some of which will benefit Willamette daisy (A. Horstman, pers. comm. 2004).

15. Bradshaw's lomatium (*Lomatium bradshawii*)

Bradshaw's lomatium (also known as Bradshaw's desert-parsley) was listed as endangered, without critical habitat designation, on September 30, 1988. This species is also on the state of Oregon's State Endangered Plant list. A recovery plan for the species was published on May 20, 2010.

Bradshaw's lomatium is a member of the Apiaceae (*Umbelliferae*) or the umbel or parsley family. The plant is a low, upright perennial arising from a long slender taproot that displays pale-yellow flowers. The plant's leaves are smooth, minutely inter-divided, glossy bluish-green, and strictly basal.

Bradshaw's lomatium flowering period peaks around the middle of April and beginning of May, but flowers may be observed as early as the first week of April through the end of May (Kagan 1980). The plant sets seed towards the middle of May and produces seed until dormancy in mid June. Over 30 species of bees, flies, wasps and beetles have been observed visiting the flowers (Kaye and Kirkland 1994). The very general nature of the insect pollinators probably buffers Bradshaw's lomatium from the population swings of any one pollinator (Kaye 1992).

Bradshaw's lomatium does not spread vegetatively and depends exclusively on seeds for reproduction (Kaye 1992). The large fruits have corky thickened wings, and usually fall to the ground fairly close to the parent. Fruits appear to float somewhat, and may be distributed by water. Research has demonstrated that Bradshaw lomatium seed does not persist long in a seed bank and will usually germinate in one season (Kaye 1992).

Bradshaw's lomatium is restricted to wet prairie habitats often associated with tufted-hairgrass (*Deschampsia caespitosa*). In wetter areas, Bradshaw's lomatium occurs on the edges of tufted-hairgrass or sedge bunches in patches of bare or open soil. In drier areas, it is found in low areas, such as small depressions, trails or seasonal channels, with open, exposed soils. These sites have heavy, sticky clay soils. Most of the known Bradshaw's lomatium populations occur on seasonally saturated or flooded prairies, which are found near creeks and small rivers in the southern Willamette Valley. The population patterns appear to follow seasonal, microchannels in the tufted-hairgrass prairies, but whether this is due to dispersal or habitat preference in not clear (Kaye 1992; Kaye and Kirkland 1994).

The species generally responds positively to disturbance. Low intensity fire appears to stimulate population growth of Bradshaw's lomatium. The density and abundance of reproductive plants increase following fires (Caswell and Kaye

2001), although monitoring showed the effects to be temporary, dissipating after 1 to 3 years. Frequent burns may be required to sustain population growth, as determined from population models (Caswell and Kaye 2001).

Population Trends and Distribution – Bradshaw's lomatium was never widely collected, and there were no known collections between 1941 and 1969, leading to the assumption that the taxon might be extinct. By 1980, following a study of the species, six populations of the species had been located, including one large population. Since 1980, over 40 new sites have been discovered, including three large populations.

For many years Bradshaw's lomatium was considered a Willamette Valley endemic, its range limited to the area between Salem and Creswell, Oregon (Kagan 1980). However, in 1994, two populations of the species were discovered in Clark County, Washington. The Oregon Natural Heritage Information Center (ORNHIC) currently lists 47 occurrences of Bradshaw's lomatium in three populations centers located in Benton, Lane, Linn, and Marion Counties, Oregon on 324 acres (131 ha). Most of these occurrences are small, ranging from about 10 to 1,000 individuals, although the largest site contains over 100,000 plants. The two Washington occurrences are larger in population size, with one site estimated to have over 800,000 individuals.

Reasons for Decline –The remaining Bradshaw's lomatium populations are threatened by development, pesticides, encroachment of woody and invasive species, herbivory, and grazing. The majority of Oregon's Bradshaw's lomatium populations are located within a 16-km (10-mile) radius of Eugene. The continued expansion of this city is a potential threat to the future of these sites. Even when the sites themselves are protected, the resultant changes in hydrology caused by surrounding development can alter the species' habitat (Meinke 1982). The majority of sites from which herbarium specimens have been collected are within areas of Salem or Eugene which have been developed for housing and agriculture (Siddall and Chambers 1978). Many Bradshaw's lomatium populations occur near roadways and other areas that are sprayed with pesticides. There is concern that these pesticides will kill the pollinators necessary for plant reproduction. Bradshaw's lomatium does not form a seed bank, therefore, any loss of pollinators (and subsequent lack of successful reproduction) could have an immediate effect on population numbers (Kaye and Kirkland 1994).

One of the most significant threats is the continued encroachment by woody vegetation. Historically, Willamette valley prairies were periodically burned, either by wildfires or by fires set by Native Americans (Johannessen et al. 1971). Since Euro-American settlers arrived, fire suppression has allowed shrubs and trees to invade grassland habitat, which will ultimately replace the open prairies.

Recovery Measures – See *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington*:

http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf for recovery goals, objectives, and criteria.

Extensive research has been conducted on the ecology and population biology of Bradshaw's lomatium (Kagan 1980; Kaye 1992; Kaye and Kirkland 1994; Caswell and Kaye 2001; Kaye and Kuykendall 2001). The results of these studies have been used to direct effective methods for habitat enhancement, propagation, and reintroduction techniques for management of the species at wet prairie sites.

Studies of the effects of cattle grazing on Bradshaw's lomatium populations show mixed results. Grazing in the springtime, when the plants are growing and reproducing, can harm the plants by biomass removal, trampling and soil disturbance; however, late-season livestock grazing, after fruit maturation, has been observed to lead to an increase in emergence of new plants, and the density of plants with multiple umbels, although it did not alter survival rates or population structure (Drew 2000). It is possible that the increase in seedlings may be due to small disturbances in the soil, a reduction of shading by nearby plants, and reduced herbivory by small mammals.

During the 2003 and 2004 fiscal years, the Partners program worked on 10 projects in Benton, Lane, Polk and Marion Counties, Oregon that restored 295 acres of wet prairie habitats, some of which will benefit Bradshaw's lomatium and other native prairie species (A. Horstman, pers. comm. 2004).

16. Cook's Lomatium (*Lomatium cookii)*

Listing Status and Description – Cook's lomatium (also known as Cook's desert-parsley) was listed as federally endangered without critical habitat designation on December 7, 2002 (67 FR 68004). This species was also listed on the state of Oregon's State Endangered Plant list. A recovery outline for this species was finalized on June 12, 2003.

Cook's lomatium is a small perennial plant in the parsley family (Apiaceae). James Kagan first collected Cook's lomatium in 1981 from vernal pools in the Agate Desert, Jackson County, Oregon, and subsequently described the species (Kagan 1986b).

Cook's lomatium is an upright 15 to 50 centimeter (cm) (6 to 30 inch [in]) tall perennial herb with a slender, twisted taproot. The taproot often branches at or below ground level, forming multiple stems. The leaves are smooth, minutely inter-divided, glossy bluish-green, and strictly basal. The pale yellow flowers are clustered into small umbels (flower clusters). Each flowering stalk produces either primarily male or female flower clusters. An umbel of female flowers will develop boat-shaped fruits 0.8 to 1.3 cm (0.3 to 0.5 in) long with thickened margins. The flowering stalk very rarely forms leaves, unlike the closely associated *Lomatium utriculatum* (foothills-parsely). The branching taproot distinguishes Cook's lomatium from Bradshaw's lomatium (indigenous to wet prairies from southern Willamette Valley, Oregon to southwest Washington) and

Lomatium humile (alkali desert parsely) (found in vernal pools in northern California) (Kagan 1986b).

Cook's lomatium flowers from late March to May and is pollinated entirely by insects. The plant produces abundant viable seeds that will often drop within close proximity to the parent plant. A single large adult plant has occasionally been found with up to 100 seedlings growing within 30 cm (11.8 in) of its leaf base (M. Sullivan, pers. comm. 2004). As seeds are buoyant, a probable mode of seed dispersion is via surface water flow. Other possible modes of dispersal are through gopher and mole subsurface excavations, ingestion by birds, insects, and small mammals, and human associated transportation of seeds via muddy shoes, tires, and farm equipment. It is likely that a majority of Cook's lomatium seed germinates each year.

Fire has played a significant historical role in the shaping of Klamath Mountain grassland habitats. Such woody early successional shrubs as *Ceanothus cuneatus* (wedge-leaved buckbrush), *Arctostaphylos spp*. (manzanita), and the exotic Cytissus spp. (broom) compete for space and sunlight with Cook's lomatium in the Illinois Valley. Eventually these shrubs will completely shade out populations of Cook's lomatium and effectively fragment habitat or displace the plant entirely. An historical fire cycle had most likely prevented such shrubs from colonizing the majority of the species' habitat in the past.

Population Trends and Distribution – In the Illinois Valley the 24 extant populations of Cook's lomatium are closely associated with seasonal wet meadows, stream banks, and forest openings on the lower valley floor. Populations range from the Selma area south to the French Flat area. Throughout the Illinois Valley range of Cook's lomatium, 16 populations occur on BLM administered land. Eight of these populations occur at the French Flat Area of Critical Environmental Concern (ACEC), four near Eight Dollar Mountain, and four near Rough and Ready Botanical Area. Two populations of Cook's lomatium overlap both BLM and State lands in the Illinois Valley. Four populations of Cook's lomatium overlap both BLM and private lands. Two populations of Cook's lomatium occur on State land.

In the Rogue Valley, 12 Cook's lomatium populations are located primarily in the central Agate Desert area with one large population occurring near the Rogue Valley Airport.

Cook's lomatium in the Illinois Valley grow on seasonally wet soils. For much of its range in the Rogue River Valley, the plant occurs on upland mounds, at the bottom of rocky vernal pools, and on vernal pools flanks. It occurs in either strongly expressed or weakly expressed vernal pool formations and appears to tolerate various types of disturbance.

In the Rogue River Valley, populations of Cook's lomatium are found in shallow Agate-Winlo complex in sparse prairie vegetation. Common plant associates include *Lupinus bicolor* (bicolor lupine), *Colinsia sparsiflora* (sparse-flowered collinsia), *Clarkia purpurea* (purple clarkia), *Erodium cicutarium* (filaree), foothills desert-parsely, *Achnatherum lemmonii* (Lemmon's needlegrass), *Poa bulbosa* (bulbous bluegrass), *Brodiaea elegans* (elegant brodiaea), *Madia spp* (tarweed), *Lasthenia californica* (goldfields), *Hemizonia fitchii* (Fitch's tarweed), and *Plagiobothrys spp* (popcornflower).

In the Illinois Valley, Cook's lomatium occurs in open wet meadows and along roadsides adjacent to meadows on Brockman clay loam, Josephine gravelly loam, Pollard loam, Eightlar extremely stony clay, Takilma cobbly loam, Abegg clay loam, and Newberg loam soils. Brockman clay loam soils in the French Flat area average 24 to 35 inches in depth. These seasonally wet soils have the ability to block water permeability through the soil, similar to the Agate Desert vernal pools, but lack that region's distinctive mound and swale topography.

Soils in the Illinois Valley are partially derived from serpentine formations that occur on surrounding slopes and hilltops. Common species in the Illinois Valley associated with Cook's lomatium include *Danthonia californica* (California oatgrass), *Chlorogalum pomeridianum* (soap plant), *Plagiobothrys bracteatus* (bracted popcornflower), *Hesperichiron californica* (hesperichiron), *Horkelia californica* (California horkelia), *Calochortus uniflorus* (short-stemmed mariposa lily), and wedge-leaved buckbrush. Two rare plants that may occasionally occur with Cook's lomatium in the Illinois Valley are *Senecio hesparius* (western senecio) and *Microseris howellii* (Howell's microseris).

Reasons for Decline –Specific threats to Cook's lomatium are off-road vehicle use, mining, road construction, logging in surrounding forests and meadows, livestock grazing, woody plant encroachment, invasion of non-native annual grasses and herbs, herbicide spraying, and dredging for gold in surrounding hills (USDI 2002c). Off-road vehicle tires create large ruts and can fracture the clay hardpan layer when soils are moist. This allows water to drain, and compromises plant survival. It is estimated that off-road vehicle use has caused the drainage of 6 hectares (15 acres) from French Flat in 2000 (USDI 2002c) and by 2004 has drained an additional 4 hectares (10 acres) (M. Mousseaux, pers. comm. 2004).

Recovery Measures – Of the four Cook's lomatium populations on Oregon Department of Transportation (ODOT) administered land, one has become extirpated. ODOT has developed three Special Management Areas. The largest known plant populations are at The Nature Conservancy's Agate Desert Preserve and at the Medford Airport. The largest locations of Cook's lomatium in the Illinois Valley occur at French Flat.

Seeds from three locations in the Rogue River Valley and two locations in Josephine County (French Flat) are stored at the Berry Botanic Garden. Germination requirements of the plant are largely unknown. Initial attempts by the Berry Botanical Garden were inconclusive. Protocols for propagation and reintroduction are likely similar to Bradshaw's lomatium, but still need to be developed. One site in French Flat is designated as an ACEC by the BLM. A section 6 grant was awarded to the ODA in 2005 to investigate cultivation and reintroduction techniques for this plant.

The Nature Conservancy protects Cook's lomatium at two preserves. Stabilization and expansion of endangered plants has been a conservation objective at the Agate Desert and Whetstone Savanna Preserve. Monitoring for effects of burning and mowing are performed annually at the two preserves (D. Borgias, pers. comm. 2004).

ODOT protects a Cook's lomatium population near Cave Junction by limiting maintenance activities during the growing season, restricting herbicide use, and finding solutions to anticipated maintenance impacts to the plants (K. Cannon, pers. comm. 2002).

17. Large-flowered Woolly Meadowfoam (*Limnanthes floccosa ssp. grandiflora*)

Listing Status and Description – Large-flowered woolly meadowfoam was listed as federally endangered on December 7, 2002 (67 FR 68004) without designated critical habitat. This species is also on the state of Oregon's State Endangered Plant list. A recovery outline for this species was finalized on June 12, 2003.

The plant is a 3 to 15-cm (2 to 6-in) tall herbaceous annual; with 1 to 5 cm (0.2 to 2 in) leaves divided into 5 to 9 segments. The leaves, stems, and lower sepals are sparsely covered with short white, fuzzy hairs. The off-white petals have two rows of hairs near their base and are nearly even with the sepals, unlike the more common woolly meadowfoam, *Limnanthes floccosa ssp. floccosa*, which has hairless petals that exceed the sepals in length. The petals of meadowfoam are 0.75 to 0.9 cm (0.30 to 0.35 in) and are slightly shorter than the sepals. Meadowfoam produces one to three flowers per flower stalk; each flower will produce a cluster of 1 to 5 hard nutlets by mid-May that will quickly drop in the drying mud. Over much of its range, meadowfoam is restricted to the relatively wetter, inner fringe of vernal pools in the Rogue Valley plains.

Meadowfoam typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable. Nutlets are produced in late April, and the plants begin to die back by mid-May or when the soil becomes dry (D. Borgias, pers. comm. 2004). Nutlets of meadowfoam apparently are dispersed by water; they can remain afloat for up to three days. However, the nutlets of the plant are normally dispersed only short distances. Thus, meadowfoam nutlets would not be expected to disperse beyond their pool or swale of origin. Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978).

Population Trends and Distribution – Meadowfoam numbers fluctuate annually depending on the seasonal precipitation and temperature, therefore the population status of the species will vary as well from year to year. In grazing allotments, sudden increases or declines in population density may be due to intensity, seasonality, and duration of grazing. In general, numbers of annual plants, such as *Limnanthes floccosa ssp. grandiflora*, may fluctuate more widely than those of perennial plants, such as Cook's lomatium. The year 2000 was a productive year for the species due to the wet conditions, but in 2001, a dry year, population numbers of the plant declined in many areas. In 2000, with average winter precipitation, numbers of plants recorded at selected vernal pools in the Agate Desert Preserve totaled 68,111, but in 2001, with an unusually dry winter, numbers of recorded plants dropped to 39,031. However, in 2002, average rainfall figures were still below normal, the population increased to 63,752 plants (D. Borgias, pers. comm. 2004). Year-to-year changes of this magnitude may be within the normal range of variation for this annual plant, but if the habitat is reasonably protected from degradation or fragmentation and the seed source protected, a population should persist.

Meadowfoam is endemic to the Rogue River Plains of Jackson County at elevations of 366 - 400 m (1,200-1,310 ft), within a 20,510 ac (8,300 ha) landform within the Agate Desert, and within the vicinity of Eagle Point and White City, Oregon.

The plant occupies the Upper and the Middle Rogue sub basins (fourth-field Hydrologic Unit Codes) of the Rogue River. Meadowfoam has no significant ecological, genetic, or geographic barriers separating its 21 extant populations apart from development and road systems. The historical distribution of meadowfoam in the Rogue Valley occurs in nine areas. Fifteen populations of the plant occur in the central Agate Desert area, one population occurs near the Rogue Valley Airfield, and an additional five populations of meadowfoam occur in the Rogue River Valley areas north of Table Rock have one population each. An additional population was recorded in Eagle Point vicinity in 1927, but the approximate site location has been developed and suitable vernal pool habitat is no longer present. In the Agate Desert, all known populations of meadowfoam comprise 80 hectares (198 acres). Three new locations were identified in the spring 2004, all at wetland mitigation sites.

Reasons for Decline – Specific threats to meadowfoam are fragmentation due to road construction, housing, industrial and commercial development, off-road vehicle damage, fill and contaminant dumping, invasion of non-native annual grasses and herbs, herbicide spraying, and poorly managed livestock grazing (USDI 2002c). Recently a known meadowfoam population in the Agate Desert near Table Rocks Road was destroyed due to disposal of contaminants (perhaps herbicide) that removed native vegetation from a 0.75 acre (0.3 ha) portion of vernal pools. The source of the spill has not yet been determined. Recreational off-road vehicle activities have impacted two meadowfoam populations in the White City area.

Recovery Measures –Through conservation easements and agreements with various parties, protection of meadowfoam and its habitats is currently being pursued. The TNC owns and manages two preserves in the area and manages a conservation easement for a third site. The Agate Desert Preserve, the Whetstone Savanna Preserve, and the Rogue River Plains Preserve total 346 ac (140 ha) in the Agate Desert, of which 252 ac (102 ha) are vernal pool habitat (D. Borgias, pers. comm. 2004). At each of the sites the TNC performs annual monitoring and performs periodic restoration activities such as burning, mowing, and controlled grazing.

Large flowered woolly meadowfoam populations occurring on two ODOT SMAs in the Agate Desert and at the Denman Wildlife Area, owned by the ODFW are protected from development.

Meadowfoam seed collected from several areas in the Agate Desert is currently stored at the Berry Botanical Garden. However, the plant is not yet a sponsored species and not fully funded for germination trials or range-wide seed collection (E. Geurrant, pers. comm. 2004).

18. Applegate's Milk-vetch (*Astragalus applegatei*)

Listing Status and Description – Applegate's milk-vetch was federally listed as endangered without critical habitat in 1993. A recovery plan was published in 1998 (U.S. Fish and Wildlife Service 1998). A 5-year status review was completed by the Service in 2009.

Applegate's milk-vetch is a tap-rooted, herbaceous perennial in the pea family (Fabaceae), with numerous trailing stems 3-8 dm (12-33 inches) long. The leaves are typically 3.5-7 cm (1.4-2.8 inches) long with 7-11 leaflets. Racemes, produced from June to October, typically have 5-20 or more small, pea-like flowers with lavender, pink, or white petals measuring up to 7 mm (0.3 inches) long that can change color as they age. Seed pods are 8-13 mm (0.4-0.6 inches) long, compressed, and have green or purple speckled valves, and contain 1-10 black seeds, each about 2 mm in diameter. Dehiscence (pod opening at maturity) starts at the top of the pod and continues downward.

Population Trends and Distribution –Applegate's milk-vetch occurs in flat-lying, seasonally moist, strongly alkaline soils sometimes dominated by greasewood (*Sarcobatus vermiculatus*), but also with rubber rabbitbrush (*Ericameria nauseosa*), and with sparse, native bunch grasses and patches of bare soil. The proximity of most sites to the Klamath River floodplain suggests flooding may have been a common occurrence historically. All sites have been invaded to varying degrees by exotic grasses and other nonnative plants that compete for space, water and nutrients with the milk-vetch.

This species was historically known from only four sites, near the city of Klamath Falls in Klamath County, Oregon, approximately 1250 m (4,100 feet) above sea level. Believed extinct until its rediscovery in 1983, it is currently know from six sites near Klamath Falls and totals approximately 30,000 plants. The largest populations are at the Klamath Falls airport, the Collins tract located along the Klamath River between Klamath Falls and Keno, and the Lake Ewauna Preserve, located in Klamath Falls, and owned by The Nature Conservancy. Population trends are only known for the Lake Ewauna Preserve site. Between 1988 and 1991, that site was estimated to contain approximately 30,000 milk-vetch plants, but by 2008, the number of plants had precipitously declined to approximately 2,000.

Reasons for Decline – Urban development, agriculture, weeds, fire suppression, flood control and land reclamation have contributed to the decline of this species. Development and competition with exotic plants is believed to be the major current threats. Another concern is the species slow reproductive rate, probably due to low survival of seedlings.

19. Malheur Wire-lettuce (*Stephanomeria malheurensis)*

Listing Status and Description – Malheur wirelettuce was federally listed as endangered with critical habitat in 1982. A recovery plan was published in 1991 (USDI 1991).

Population Trends and Distribution – Malheur wirelettuce occurs at only one location on approximately 70 acres of public lands managed by the BLM. The first discovery of Malheur wirelettuce was in 1966 when seeds of this species were collected with those from a population of its ancestral plant, small wirelettuce. This species is an annual and its numbers vary greatly from year to year, depending largely on the amount of precipitation prior to and during the spring growing season. In 1974, the population was estimated at 228 plants and in 1975 the numbers grew to 1,050. During the 1980's, very low numbers of plants were found, and in 1985, 1986 and 1999, no plants were observed. During this time when the species numbers dwindled to zero, cheatgrass (*Bromus tectorum*) an extremely aggressive non-native grass species dramatically increased at the site. A reintroduction program was begun in April 1987 and 1000 seedlings obtained from the Berry Botanic Garden were transplanted into study plots at the site. Of these plants, 412 survived and one wild plant was found. During subsequent years, efforts have been undertaken to remove cheatgrass from around existing plants and study plots; however, numbers of Malheur wirelettuce remain low.

Malheur wirelettuce is an annual plant in the composite family (*Asteraceae*). It can reach 5 dm (20 inches) in height. This species forms a rosette of hairless leaves that arise from its base. The single stems are many-branched with scale-like leaves. Flower heads are either numerous and clustered, or solitary on short stems. The strap-shaped petals are pink, white, or rarely orange-yellow. Flowering typically occurs in July and August.

The Malheur wirelettuce is co-located with an ancestral relative, small wirelettuce (*Stephanomeria. exiqua ssp. coronaria*); however, the two species do not interbreed. While the Malheur wirelettuce is self-pollinating, its ancestral relative is not.

Malheur wirelettuce occurs in the high desert of the northern portion of the Great Basin and is located in an area south of Burns, Oregon. It occurs on top of a dry, broad hill on volcanic soil intermixed with layers of limestone. Dominant plants at the site are big sagebrush (*Artemisia tridentata*), gray rabbitbrush (*Chrysothamnus nauseosus*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and, more recently, cheatgrass. Malheur wirelettuce may be one of the few species able to survive on and around the otherwise barren harvester ant hills at the site.

Reasons for Decline – Malheur wirelettuce is in great danger of extinction due to its small population size. Natural fluctuations in population numbers that occur in response to variations in annual rainfall and spring frosts are particularly problematic for small populations. The species is also vulnerable to habitat alteration; surface mining for zeolite was a potential threat at the time of listing. Other immediate threats include competition from cheatgrass and predation by native herbivores such as black-tailed jackrabbits.

Recovery Measures – Critical habitat for Malheur wirelettuce was designated at the time of listing in 1982. This designation identifies the specific area containing the necessary physical and biological requirements for the conservation of the species. The designation of critical habitat provides additional protection for the species. The area within the designated critical habitat was set aside to allow for natural expansion of the population and to provide a buffer against potential adverse impacts from activities on adjacent lands. In 1984, the Bureau of Land Management (BLM) designated the known location of Malheur wirelettuce as the South Narrows Area of Critical Environmental Concern. The 160-acre area has been fenced since 1974 to prevent grazing by livestock. Monitoring of Malheur wirelettuce population is regularly conducted by BLM botanists. In 1986 the Service completed the Malheur Wirelettuce Recovery Plan which identified various tasks that are necessary to recover the species. The primary tasks are to maintain and enhance existing populations and habitat, conduct systematic searches for new populations, secure any newly found populations, and develop management and monitoring programs for the species. The U.S. Fish and Wildlife Service, in cooperation with the BLM, developed the "Study Plan for *Stephanomeria malheurensis*" to identify research needs and management options for the maintenance of a viable self-perpetuating population of Malheur wirelettuce.

20. Golden paintbrush (*Castilleja levisecta*)

Listing Status and Description – Golden paintbrush was federally listed as endangered, without critical habitat, on June 11, 1997. This species is also on the state of Oregon's State Endangered Plant list. A recovery plan was published for

the species on August 23, 2000. Additional recovery guidelines are provided in *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington*: http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf.
Golden paintbrush is a perennial herb that often forms 5-15 un-branched stems. The plant grows up to 51 cm (20 in) cm tall and is covered with soft, slightly sticky hairs. Golden paintbrush flowers are mostly hidden by showy golden-yellow bracts, hence its name. The plant flowers from April to June. Fire is thought to have historically played a key role in the maintenance of the seasonally wet open prairie habitats occupied by this species.

Population Trends and Distribution – The taxon is a regional endemic with a historic range west of the Cascade Mountain Range from the southern tip of Vancouver Island, Canada to Linn County, Oregon. In Washington, the species occurs in the Puget Trough physiographic province. The taxon is believed to be extirpated from the Willamette Valley physiographic province of Oregon. Historically, golden paintbrush was found as far north as the Puget Trough of Washington and British Columbia, and as far south as the Willamette Valley of Oregon. Most populations are found on the islands that make up the San Juan Islands. The southern-most extant occurrence of golden paintbrush is in Thurston County, Washington.

Reasons for Decline – Prairie destruction due to residential, commercial, or agricultural use is a threat at five of the six privately owned sites (USDI 2000c). Many populations have destroyed by the conversion of its native prairie habitat to agricultural, residential, and commercial uses. The decline of golden paintbrush is also correlated with fire exclusion. Fire disturbance is an integral component of the prairie ecosystem, maintaining grassland by preventing the successional encroachment of woody shrubs and trees. As a direct consequence of these land-use changes, golden paintbrush has not been seen in Oregon for over 40 years and is now endangered in Washington. High intensity, hot-burning fires resulting from years of fire suppression and plant material build-up can completely eliminate plants and to some extent a seed bank. In communities evolved to periodic fire conditions, hot-burning fires may kill the plants (USDI 2000c). Competition from non-native, invasive species such as Hieracium pilosella (mouse-ear hawkweed), *Cytisus scoparius* (Scotch broom) and *Leucocephalum vulgare* (ox-eye daisy), and other non-native plants can severely degrade golden paintbrush habitat (Wentworth 1998). An increasing cover of native shrubs is also of concern at some sites. Herbivory by rabbits and deer, and trampling by recreationists can retard flower output during the growing season and undermine seed production (Wentworth 2000).

In the absence of active management, fairly vigorous populations of *Castilleja levisecta* have rapidly declined to extinction within a few decades. Alarmingly, these declines did not result from overt habitat destruction, but from the 'invisible' threats associated with low population numbers, in-breeding depression, fire-suppression and weed invasion. Presently, no site contains enough golden paintbrush individuals to be immune to drastic, irreversible declines.

Recovery Measures – Both federal agencies and private parties are vital in the conservation of the nine remaining populations in Washington and two remaining populations in British Columbia. Whidbey Island Naval Air Station monitors and manages a large population on its land. A private landowner, Robert Pratt, specified in his will that 147 acres of his estate, which contained a significant golden paintbrush population, would go to a nonprofit conservation group. Upon his death in 1999, The Nature Conservancy acquired this land and worked with the National Park Service to purchase another 380 adjoining acres. Congress appropriated funds for the Pratt reserve, and The Nature Conservancy borrowed the remaining money needed to expedite this purchase. In southern Vancouver Island, the Garry Oak Ecosystems Recovery Team is working to save over 100 endangered species, including golden paintbrush. These efforts are essential for the continued survival of golden paintbrush. Steps to increase population sizes and establish new populations are necessary to ensure long term survival of golden paintbrush. The University of Washington's Center for Urban Horticulture, also a Participating Institution of the Center for Plant Conservation, is actively involved in these efforts.

Monitoring and management occurs regularly at Whidbey Island Naval Air Station. A large golden paintbrush population is monitored and managed by The Nature Conservancy at the Pratt Preserve. Sites in British Columbia are in designated "Ecological Reserve" land. Entry is restricted and plant collection and resource destruction are not allowed (USDI 2000c). Recently studies to assess the potential for golden paintbrush to establish in the Willamette Valley, conducted in the Willamette Valley in Oregon, concluded that establishment could be successful following specific propagation prescriptons (Lawrence 2005).

21. Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*)

Listing Status and Description – Kincaid's lupine was listed as threatened, on January 25, 2000 (USDI 2000b). This species is also on the state of Oregon's State Threatened Plant list. Designated critical habitat was proposed for Kincaid's lupine on November 2, 2005 (USDI 2005). A recovery plan was finalized for this species on May 20, 2010.

Kincaid's lupine is a long-lived perennial species with a maximum reported age of 25 years. Individual plants are capable of spreading by rhizomes, producing clumps of plants exceeding 20 meters (m) (33 feet [ft]) in diameter. Population counts are thus unreliable, and apparently large populations may consist of few genetic individuals. Leaves are oval-palmate, with very narrow leaflets. The small, purplish-blue pea flowers grow in loose racemes that are 15.2 to 20.3 cm (6 to 8 in) tall. The flowering period has been reported from May to July (Eastman 1990) and from April to June (Hitchcock *et al.* 1961), but generally occurs during May and June. Above-ground portions of the plant usually wither and die by mid-August (USDI 2005). Self-incompatible, Kincaid's lupine must obtain pollen from another individual plant to produce fertile seeds and is therefore, dependent on solitary bees and flies for pollination. Seed set and seed production are low, with few flowers producing fruit from year to year and each fruit containing an average of 0.3 to 1.8 seeds. Seeds are dispersed from fruits that open explosively upon drying. Kincaid's lupine is the primary host food plant for Fender's blue caterpillars, and the two species are currently known to co-occur at 25 sites on approximately 279 ac (113 ha) across their ranges.

Population Trends and Distribution – Kincaid's lupine occurs in 76 remnant upland prairie occurrences, totaling approximately 1,150 ac (465 ha) in size, scattered across six counties (Lewis County, Washington, and Yamhill, Polk, Benton, Lane, and Douglas Counties, Oregon). Within the Willamette Valley, Kincaid's lupine occupies 86 habitat patches totaling approximately 345 ac (140 ha) in size. In the Umpqua Valley, Douglas County, Oregon, Kincaid's lupine occupies eight small patches, averaging 14 ac (5.7 ha) in size, and in Lewis County, Washington, three tiny patches, totaling approximately 0.49 ac (0.2 ha) in size.

Reasons for Decline – Prairie has been lost due to fire suppression and subsequent woodland succession. Most Willamette Valley prairies are thought to be early seral habitats, requiring natural or human- induced disturbance, particularly fire, for their maintenance (Franklin and Dyrness 1973). Before European settlement, the native Kalapuya people are attributed with maintaining prairie habitats through prescribed burning (Boyd 1986). A serious long-term threat to all Willamette Valley prairie species is the change in community structure due to plant succession. Without active management, the natural succession of prairie to shrub/forest by the invasion of native species, such as Oregon ash (*Fraxinus latifolia*), Douglas hawthorn (*Crataegus douglasii*), Nutka rose (*Rosa nutkana*) and Douglas spiraea (*Spiraea douglasii*), will lead to the eventual loss of these prairie sites (Hammond and Wilson 1993; Kuykendall and Kaye 1993). The presence of invasive non-native woody species, such as Himalayan blackberry (*Rubus discolor*), multiflora rose (*Rosa multiflora*) and Scotch broom (*Cytisus scoparius*), exacerbate this problem. Shrub and tree intrusion has been documented on most of the relic prairie sites occupied by Kincaid's lupine and Fender's blue butterfly (USDI 2005).

Over 80 percent of the remaining upland prairies (mostly in the Willamette Valley) where these species is known to occur are threatened by agriculture and forest practices, development, grazing, and road construction and maintenance. Kincaid's lupine is thought to have originally been widely distributed on upland prairie habitats throughout the Willamette Valley, with the lupine extending into the Umpqua Valley, Oregon.

Kincaid's lupine is generally associated with native fescue upland prairies that are characterized by heavier soils, with mesic to slightly xeric soil moisture levels. At the southern limit of its range, the subspecies occurs on well-developed soils adjacent to serpentine outcrops where the plant is often found under scattered oaks (Kuykendall and Kaye 1993). Within the Willamette Valley Kincaid's lupine occurs in generally open upland prairie and open oak savannah. Kincaid's lupine is thought to have historically colonized areas along the edge of oak woodlands throughout upland prairies. Schultz (1998) theorizes that lupine patches were historically distributed no greater than 0.5 kilometers (km) (0.3 miles [mi] apart, allowing dispersal of Fender's blue butterfly between lupine patches.

Fence rows, pastures, and intervening strips of land along agricultural fields and roadsides are often the only remaining refugia for native upland prairie plants. Therefore, native endemic plants often occur in small and fragmented populations. Generally, the direct and indirect effects of small population size on most species of plants and animals include decreased dispersal ability, decreased rate of genetic exchange, a resultant loss of population viability and vigor, and a hastening towards extinction (Gilpin and Soule 1986).

The modern use of herbicides for highway or roadway maintenance, farming practice, or other land uses for weed control and landscape maintenance purposes is further exacerbating the precarious survival of these remnant plant populations. That is, some of the remnant Kincaid's lupine populations occur within weedy sites, and spraying nonspecific contact herbicides eliminates all existing plant species.

Recovery Measures – See *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* (USFWS 2010b; http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf) for recovery goals, objectives, and criteria.

F. Insects and Mollusks

1. Fender's Blue Butterfly

Listing Status and Description – Listed as endangered in 2000 with critical habitat designated in 2006, Fender's blue butterfly is known to use Kincaid's lupine as its primary larval food plant but is also known to use spur lupine *(Lupinus laxiflorus = L. arbustus)* and sickle-keeled lupine *(L. albicaulis*) as secondary host plants. Female Fender's blue butterflies lay their eggs on lupine foliage in late May or early June; and larvae emerge to feed on foliage during late June. In July, larvae crawl to the base of the plant and enter diapause. From this point until the larvae emerge and begin feeding on foliage again the following April, the larvae remain at the base of the senescent plant, or in the litter immediately adjacent to the lupine stem. Fender's blue butterfly density has been positively correlated with the number of Kincaid's lupine flowering racemes, and more recently, to nectar production in native flowering species used as nectar sources by Fender's blue butterfly. Survivorship of larvae to adult butterflies has been estimated at 0.025 to 0.060 percent (Schultz and Crone 1998).

Research (Schultz and Dlugosh 1999) indicates that native wildflowers in the Willamette Valley prairies provide more nectar than nonnative flowers for adult butterflies, and that Fender's blue butterfly population density is positively correlated with the density of native wildflowers. In Lane County, key native flowers include: wild onion, (*Allium amplectans*), cat's ear mariposa lily (*Calachortus tolmiei*), common camas (*Camassia quamash*), Oregon sunshine (*Eriophyllum lanatum*), and rose checkermallow (*Sidalcea virgata)* (Schultz and Dlugosch 1999). Tall oatgrass (*Arrenatherum elatius*) and other non-native grasses can out-compete these native forb species (Hammond 1996). The abundance of exotic grasses can effectively preclude butterflies from using a Kincaid's lupine occurrence (Hammond 1996).

The Primary Constituent Elements for Fenders Butterfly critical habitat are (1) Early seral upland prairie, oak savanna habitat with undisturbed subsoils that provides a mosaic of low growing grasses and forbs, and an absence of dense canopy vegetation allowing access to sunlight needed to seek nectar and search for mates; (2) Larval host-plants: *Lupinus sulphureus* ssp. *kincaidii*, L. *arbustus*, or *L*. *albicaulis*; (3) Adult nectar sources, such as: *Allium acuminatum* (tapertip onion), *Allium amplectens* (narrowleaf onion), *Calochortus tolmiei* (Tolmie's mariposa lilly), *Camassia quamash* (small camas), *Cryptantha intermedia* (clearwater cryptantha), *Eriophyllum lanatum* (woolly sunflower), *Geranium oreganum* (Oregon geranium), *Iris tenax* (toughleaf iris), *Linum angustifolium* (pale flax), *Linum perenne* (blue flax), *Sidalcea campestris* (Meadow checkermallow), *Sidalcea virgata* (rose checker-mallow), *Vicia cracca* (bird vetch), *V. sativa* (common vetch) and *V. hirsuta* (tiny vetch); (4) Stepping stone habitat: Undeveloped open areas with the physical characteristics appropriate for supporting the short-stature prairie, oak/savanna plant community (well drained soils), within and between natal lupine patches (~1.2 miles (~2 km)), necessary for dispersal, connectivity, population growth, and, ultimately, viability.

Population Trends and Distribution – Censuses of Fender's blue butterfly were started in 1991; most of the 22 census units have been surveyed every year since 1993 (Hammond and Wilson 1993; Hammond 1994, 1996, and 1998; Schultz 1998).

Total range-wide population numbers (once most occurrences were monitored) of Fender's blue butterflies have ranged from a low of 1,384 adults in 1998 to a high of 3,492 adults in 2000 (Appendix A2). Although population size appears to have increased between 1998 and 2000, this may be a result of poor weather conditions in 1998, and thus poor flight conditions. It may also be an artifact of increasing survey effort at these occurrences. However, some of this increase may be attributed to habitat enhancement activities, such as tree and shrub removal from lupine occurrences (USDI 2005).

Fender's blue butterfly is a Willamette Valley endemic subspecies that was considered to be extinct until rediscovered by Dr. Paul Hammond in 1989 in McDonald Forest, Benton County, Oregon. The historical distribution of

Fender’s blue butterfly is not precisely known, due to the limited information collected on this species before its description in 1931. Recent surveys have determined that Fender’s blue butterfly is confined to 33 habitat occurrences in Yamhill, Polk, Benton, and Lane counties, Oregon. One population at TNC’s Willow Creek Preserve in Eugene, Lane County, Oregon is found in wet *Deschampsia*-type prairie, while the remaining occurrences are generally found on drier upland prairies characterized by fescue species. The Willow Creek aggregate of populations is the largest of the south valley occurrences (USDI 2005).

Reasons for Decline – Anecdotal evidence indicates that under ideal conditions adult Fender's blue butterflies may disperse as far as 5 to 6 km (3.1 to 3.7 mi) from their natal lupine occurrences (Hammond and Wilson 1992). Hammond (1998) reports recolonization of a site by Fender’s blue butterfly from a distance of approximately 3 km (1.9 mi). Schultz (1997) further theorizes that Fender’s blue butterfly originally had a high probability of dispersing between occurrences that were historically located an average of 0.5 km (0.3 mi) apart. Current distribution of lupine occurrences range well beyond this distance, and barriers to migration between close occurrences may be present (USDI 2005).

Today, remnant upland prairie acreage is extremely fragmented and remaining Fender’s blue butterfly populations are so small that migration processes are not expected to maintain the population over time. Extirpation of remaining small populations is expected from localized events and low genetic diversity of very small populations. The low availability of host lupine occurrences and fragmentation of habitat are seen today as the major ecological factors limiting reproduction, dispersal, and subsequent colonization of new habitat (Hammond 1994; Schultz and Dugosch 1999).

Recovery Measures – Many partners have grouped together to improve habitat for the butterfly. On May 20, 2010 a Recovery Plan ws signed which lays out general direction for activities to enhance survival and recovery of the species. The Eugene BLM is currently developing a Resource Management Plan (RMP) to guide further management activities on their land in the West Eugene Wetlands.

IV. Action Area and Environmental Baseline

A. Description of Action Area

This ARBA II covers those portions of Oregon and Washington wherever BLM, FS, and Coquille Indian Tribe administrative units are found. It also covers portions of administrative units that are primarily located in Oregon and Washington, but overlap into California (Rogue/Siskiyou NF), Nevada (Lakeview and Vale BLM Districts) and Idaho (Wallow Whitman NF). This ARBA II covers aquatic restoration projects that occur within the range of listed species under the ESA of 1973 as amended and current critical habitat. Further, the programmatic area includes non-federal lands where activities help achieve aquatic restoration goals on BLM and FS administered lands. To be included, such non-federal land projects must follow all aspects of the proposed action described in this ARBA II.

Contained within the geographic area, site-specific Action Areas are located in fish and non-fish bearing streams, riparian areas, and uplands that have a direct link to restoration of aquatic habitat. The action area includes all areas to be affected directly or indirectly by the programmatic activities and not merely the immediate project area. Pre-implementation analysis of effects within the action area will determine take of listed specie(s) and overall take of a project.

B. Environmental Baseline for ESA Listed Species

This ARBA II will only address the environmental baseline for species and critical habitat that aquatic restoration projects "May Affect, Likely to Adversely Affect". The environmental baseline includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). This ARBA II describes the environmental baseline in terms of the biological requirements for habitat features and processes necessary to support all life stages of ESA/MSA listed species within the action area. When the environmental baseline departs from those biological requirements, the adverse effects of a proposed action on a specie(s) or its habitat are more likely to jeopardize the listed specie(s) or result in destruction or adverse modification of critical habitat.

The biological requirements of salmon and steelhead in the action area vary depending on the life history stage present and the natural range of variation present within that system (Spence et al. 1996). Generally, during spawning migrations, adult salmon require clean water with cool temperatures and access to thermal refugia, dissolved oxygen near 100% saturation, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. Anadromous fish select spawning areas based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling. Embryo survival and fry emergence depend on substrate conditions (e.g., gravel size, porosity, permeability, and oxygen concentrations), substrate stability during high flows, and, for most species, water temperatures of 13°C or less. Habitat requirements for juvenile rearing include seasonally suitable microhabitats for holding, feeding, and resting. Migration of juveniles to rearing areas, whether the ocean, lakes, or other stream reaches, requires access to these habitats. Physical, chemical, and thermal conditions all may impede movements of adult or juvenile fish.

Each fish species considered in this ARBA II resides in or migrates through the action area. Thus, for this action area, the biological requirements for fish are the habitat characteristics that support: 1) successful spawning; 2) rearing; and 3) successful juvenile and adult migrations. Water quality, natural cover, substrate, and forage are the habitat features most likely to be affected by the proposed action and are the focus of the effects analysis.

The quality and quantity of fresh water habitat in much of Oregon and Washington has declined dramatically in the last 150 years. Land management activities that have degraded habitat of salmonids (and other native fishes) include water withdrawals, unscreened water diversions, hydropower development, road construction, timber harvest, stream cleaning of large wood, splash dams, mining, farming, livestock grazing, outdoor recreation, and urbanization (USDA and USDI 1994; Lee et al. 1997; Spence et al. 1996). In many river basins, land management activities have: 1) reduced connectivity (i.e., the flow of energy, organisms, and materials) between streams, riparian areas, floodplains, and uplands; 2) elevated fine sediment yields, filling pools and reducing spawning and rearing habitat; 3) reduced instream and riparian large wood that traps sediment, stabilizes stream banks, and helps form pools; 4) reduced or eliminated vegetative canopy that minimizes temperature fluctuations; 5) caused streams to become straighter, wider, and shallower, which has the tendency to reduce spawning and rearing habitat and increase temperature fluctuations; 6) altered peak flow volume and timing, leading to channel changes and potentially altering fish migration behavior; 7) altered floodplain function, water tables and base flows, resulting in riparian wetland and stream dewatering; and 8) degraded water quality by adding heat, nutrients and toxicants (USDA and USDI 1994; Lee et al. 1997; McIntosh et al. 1994; Spence et al . 1996).

While there has been substantial habitat degradation across all land ownerships, habitat in many BLM and FS headwater stream segments is generally in better condition than in the largely non-Federal lower portions of tributaries (Lee *et al*. 1997). Because Federal lands are generally forested and situated in upstream portions of watersheds, BLM and FS lands now contain much of the highest quality salmon and steelhead habitat remaining in Oregon and Washington.

ESA wildlife species and critical habitat that aquatic restoration projects May Affect, Likely to Adversely Affect are: marbled murrelets and Northern spotted owls. Murrelet declines are due to old-growth coniferous forest loss as well as predation by corvids. From 1974 through 1993, approximately 64% of the nests failed where nest success/failure was documented, and 57% of those that failed were due to predation (primarily by ravens, crows, and jays) (USFWS 1997).

Northern spotted owl declines on FS, BLM and Coquille Tribal lands are due in part to the high density of barred owls, loss of habitat due to wildfire, harvest of habitat, poor weather conditions, and forest defoliation caused by insect infestations.

V. Effects of the Programmatic Actions

Each of the ARBA II aquatic restoration categories listed in Table 9 may have varying degrees of direct and indirect effects to aquatic and terrestrial ESA-listed species and their Critical Habitat (CH) and Essential Fish Habitat (EFH). Direct effects cause an immediate impact. Indirect effects are those effects that occur later in time. Effects of most concern under this programmatic consultation are those resulting from short-term habitat removal or degradation or impacts that cause changes to listed species' growth, reproduction, and survival. The aquatic conservation measures and project design criteria listed in Chapter II are intended to minimize potential adverse direct and indirect project effects to ESA/MSA listed species, CH, and EFH.

The effects of restoration activities on individual fish, CH, and EFH are described in context of the Matrix of Pathways and Indicators (MPI) developed by FWS and NOAA Fisheries (1999). Part "A" of this chapter will describe the MPI and the rationale for a "May Affect, Likely to Adversely Affect" (LAA) determination for ARBA II projects. Part "B" of this chapter includes full descriptions of each MPI indicator, the ways in which the proposed ARBA II actions will affect the indicators, and conclusions regarding ESA effects to the species and designated CH. Part "C" of this chapter describes the relationship between use of the MPI to determine effects to listed fish species and analyses for effects to CH and EFH. In another way, the analysis of effects to listed species using the MPIs is used to determine the effects to CH and/or EFH.

A. Process for Assessing Effects of the 20 ARBA II Aquatic Restoration Categories using the Matrix of Pathways and Indicators

1. **Matrix of Pathways and Indicators** – The effects of the programmatic actions will be analyzed using the MPI. The following MPI indicators were used in this analysis: 1) Temperature; 2) Turbidity; 3) Chemical Contamination/Nutrients; 4) Physical Barriers; 5) Substrate/Sediment; 6) Large Wood; 7) Pool Frequency and Quality; 8) Off-Channel Habitat; 9) Refugia; 10) Width/Depth Ratio; 11) Streambank Condition; 12) Floodplain Connectivity; 13) Changes in Peak/Base Flows; 14) Increase in Drainage Network; 15) Road Density and Location; 16) Riparian Reserves; 17) Disturbance History; 18) Fish Population Characteristics. Category number 18 incorporates four FWS indicators: Subpopulation Size, Growth and Survival, Life History, and Genetic Integrity.

   The effects analysis is organized around the following seven MPI Pathways:

   a) **Water Quality:** 1) Temperature; 2) Turbidity; 3) Chemical Concentration/Nutrients
   b) **Habitat Access:** 4) Physical Barriers
   c) **Habitat Elements:** 5) Substrate/Sediment; 6) Large Wood; 7) Pool Frequency and Quality; 8) Off-Channel Habitat; 9) Refugia
   d) **Channel Condition and Dynamics:** 10) Width/Depth Ratio; 11) Streambank Condition ;12) Floodplain Connectivity
   e) **Flow/Hydrology:** 13) Changes in Peak/Base Flows; 14) Increase in Drainage Network
   f) **Watershed Condition:** 15) Road Density and Location; 16) Riparian Reserves; 17) Disturbance History
   g) **Fish** : 18) Fish Population Characteristics

2. **General Effects of the 20ARBA II Aquatic Restoration Categories –** Aquatic restoration activities proposed in this ARBA II are considered to Likely Adversely Affect (LAA) ESA listed fish species and designated CH and May Adversely Affect (MAA) MSA Essential Fish Habitat. LAA projects are those that a) will cause more than negligible disturbance to riparian soil or vegetation, streambanks, or channels; or b) will be completed inside or outside the Riparian Reserves (NWFP), RHCAs (PACFISH and INFISH), or equivalent Riparian Management Areas (a possible result of future RMP revisions) such that the intensity and duration of any disturbance caused is likely to increase total suspended solids and impair the function of aquatic habitats or essential fish behavior; or c) include pursuit or capture of ESA-listed fish.

   As implemented under the project design criteria listed in Chapter II, ARBA II activities will result in negative short-term impacts to the baseline condition of MPI indicators, resulting in a conclusion of "May Affect, Likely to Adversely Affect" for ESA-listed fish species and designated CH, and "May Adversely Affect" for EFH. Regarding the Matrix of Pathways and Indicators, the ARBA II Team determined that the Water Quality (Turbidity) and Habitat Elements (Substrate/Sediment) pathways will be negatively impacted for all activity categories except the *Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration* category. The ARBA II Team arrived at this conclusion because all proposed actions will occur in the stream channel and/or throughout the adjacent floodplain up to the bankfull channel, both of which can result in increased stream turbidity/sediment or disturbance of ESA-listed fish.

   The primary cause of project related sediment will be heavy machinery use in floodplains and/or along or within the stream channels. Heavy machinery consists of mobile equipment such as excavators, bulldozers, backhoes, and dump trucks and does not include handheld equipment, such as chainsaws. During project implementation within a bankfull channel, the use of heavy equipment will disturb channel substrates and promote suspension of fine sediments in the water column, creating a short-term (hours) turbidity plumes. Soil disturbance and exposure—resulting from heavy machinery or moderate intensity controlled burns—in the adjoining floodplain will result in erosion into the stream during precipitation events, but such events will be minimized in duration through site restoration conservation measures. Harm or harassment of ESA-listed fish will occur from the pursuit, capture, transport, and release of such fish for certain actions prior to activities or indirectly by displacement or injury during project implementation for all 20 activity categories.

   Finally, the ARBA II Team determined that there is the potential for adverse effects from herbicide use under the Non-Native Invasive Plant Control category. As discussed below (section B.1.d), however, the combination of application methods, low toxicity herbicides, and PDC are likely to restrict adverse effects from herbicide exposures on listed fish to infrequent, short-term occurrences.

B. Effects of ARBA II Programmatic Activities on Matrix Indicators

The following discussion presents the effects of programmatic activities on individual indicators. The ARBA II Activities are intended to "Enhance" conditions at the site scale and move a 5th field watershed baseline towards a "Restore" rating over the long-term. All of these programmatic actions may result in some degree of short-term adverse effects to fish or their habitat.

1. Water Quality Pathway

a. **Indicator Description –** The description of the following three pathway indicators provides the ways in which they serve as essential ecological functions necessary for the overall viability of fish stocks: Water Temperature, Sediment/Turbidity, and Chemical Contamination/Nutrients.

i. **Water Temperature –** Water temperatures affect the survival and production of fish throughout all life stages. For instance, a study of Chinook salmon survival from fertilization to hatching demonstrated that those eggs incubated at 15.0˚C had a 23% survival rate while those incubated at 9.9 and 11.4˚C had a 49 and 50% survival rate, respectively (Garling and Masterson 1985). In Chum salmon, embryo survival was demonstrated to be highest at 11˚C (Murry and McPhail 1988), hatching success of rainbow trout reaches its maximum at 10-12˚C (McCullough 1999), and preferred temperatures for bull trout ranges are 2-4˚C (McPhail and Murray 1979). Next, changing water temperatures affect juvenile fish. Cairns et al. (2005) documented that increased temperatures in an Oregon stream resulted in higher neacus-type trematode infestations of juvenile salmonids. Further, juvenile (fry, fingerling, parr) Chinook demonstrate optimum growth between 10.0-15.6˚C (Armour 1990), while growth drastically declines or ceases at 19.1˚C (Armour 1990) and is accompanied by decreased feeding, increased stress, and warm water diseases. Juvenile bull trout are usually found in water temperatures below 12˚C (Goetz 1994). Finally, at a certain point, temperatures become lethal for all fish. McCullough (1999), citing numerous studies, stated that temperatures above 21˚C equal or exceed incipient lethal temperatures for Columbia River Chinook stocks and steelhead stocks migrating during the summer season. The best bull trout habitat in Oregon streams seldom exceeded 15˚C (Buckman et al. 1992; Ratliff 1992; Ziller 1992). Modoc suckers are typically found in streams with relatively cool (59-72° F) summer temperatures (Moyle 2002), and the Warner sucker spawns most frequently when stream temperatures range between 14-20˚C (USDI 1998c).

ii. **Turbidity –** Increased levels of sedimentation often have adverse effects on fish habitats and riparian ecosystems. Fine sediment deposited in spawning gravels can reduce egg survival and developing alevins (Everest et al. 1987; Hicks et al. 1991) by reducing the availability of dissolved oxygen in the gravel. Primary production, benthic invertebrate abundance, and thus, food availability for fish may be reduced as sediment levels increase (Cordone and Kelley 1961; Loyd et al. 1987) due to reductions in photosynthesis within murky waters. Social (Berg and Northcoate 1985) and feeding behavior (Noggle 1978) can be disrupted by increased levels of suspended sediment. Pools, which are an essential habitat type, can be filled by sediment and degraded or lost (Kelsey et al. 1981; Megahan 1982). Robichaud et al. (2010) documented that sediment influxes into streams, which create turbidity, were lower in natural (undisturbed) forests relative to disturbed sites created by land management activities. Reeves et al. (1995) describe that sediment influxes and resulting turbidity occurs through naturaly occurring landslides in western Oregon.

iii. **Chemical Contamination/Nutrients –** Aquatic ecosystem perturbations related to chemical contamination include thermal pollution, toxicity due to organic compounds and heavy metals, organic wastes and resulting changes in dissolved oxygen, acidification, and increased eutrophication. Sources of these chemical inputs commonly result from industry, urban development and agriculture. It is clear from the growing body of literature that salmon may influence the food webs, trophic structure, nutrient budgets, and possibly the productivity of freshwater and terrestrial systems, although the effect varies widely between systems and is contingent upon timing, scale, retention mechanisms, alternative nutrient sources, and baseline limiting factors (Gende et al. 2002). Reduced inputs of salmon-derived organic matter and nutrients (SDN) may limit freshwater production and thus establish a negative feedback loop affecting future generations of fish. Restoration efforts use the rationale of declining SDN to justify artificial nutrient additions, with the goal of reversing salmon decline. Biological responses to this method have also been documented (Roni et al. 2002). Elevated primary production and density of invertebrates have been associated with carcass additions (Wipfli et al. 1999). Kohler et al. (2012) documented that invertebrate productivity and fish growth increased after a carcass analog treatments in several Columbia River Basin streams. While evidence suggests that fish and wildlife may benefit from increases in food availability as a result of carcass additions, stream ecosystems vary in their ability to use nutrients to benefit salmon. Moreover, the practice may introduce excess nutrients, disease, and toxic substances to streams that may already exceed proposed water quality standards (Compton 2006).

b. Long-term Benefits of ARBA II Activities to the Water Quality Pathway – The ARBA II Team (BLM, FS, BIA, FWS, NMFS) determined that numerous ARBA II activity categories will provide immediate and long-term benefits to Water Quality conditions: Large Wood, Boulder, and Gravel Placement; Dam, Tidegate, and Legacy Structure Removal; Channel Reconstruction/Relocation; Off- and Side-Channel Habitat Restoration; Streambank Restoration; Set-back or Removal of Existing Berms, Dikes, and Levees; Reduction/Relocation of Recreation Impacts; Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering; Piling and other Structure Removal; In-channel Nutrient Enhancement; Road and Trail Erosion Control and Decommissioning. Other ARBA II activity categories may not provide immediate benefits but will provide long-term benefits to Water

Quality conditions: Non-native Invasive Plant Control; Juniper Removal; Riparian Vegetation Treatment (controlled burning); Riparian Vegetative Planting; Beaver Habitat Restoration; Sudden Oak Death Treatments.

In general, the ARBA II aquatic restoration categories listed above will improve or restore one or more of the following: stream structure/complexity, stream sinuosity and length, bank stability, floodplain connectivity, and riparian vegetation structure and diversity. Such results will promote conditions that maintain or decrease stream temperature (via increased shading and hyporheic flow), reduce turbidity (via stable banks, improved sediment retention through increased channel structure, riparian areas, and floodplains), and improved nutrient input (via increased riparian allocthonous sources) and retention (via increased channel structure, sinuosity, and floodplain areas).

c. **Short-term Negative Impacts of ARBA II Activities to the Water Quality Pathway (excluding Non-Native Invasive Plant Control and Sudden Oak Death Treatments) –** As described above, ARBA II activity categories are expected to benefit the Water Quality Pathway. In acquiring these benefits, short-term negative impacts are expected. Such effects will be minimized by incorporating Aquatic Conservation Measures (ACM) and Project Design Criteria (PDC) described in Chapter II into project design, implementation, and monitoring.

The ARBA II Team determined that all activity categories (except In-channel Nutrient Enhancement and Fisheries and Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration categories) are known to increase short-term sediment loads into a stream channel during project implementation. Increased sediment loads would result from the use of large equipment within or near a stream channel and soil exposure through controlled burning, causing soil disturbance and transport within the stream system. The ARBA II Team also concluded that these activities are unlikely to have negative impacts to stream temperatures because only minimal amounts of vegetation will be removed. For instance, Riparian and Upland Juniper Treatment (non-commercial), and Riparian Vegetation Treatment (controlled burning) will result in reduced shade on a limited basis and in such a manner as to have discountable impacts to water temperature; these impacts will be ameliorated through growth of desired riparian vegetation. Further, the ARBA II team determined that the General Aquatic Conservation Measures, described in Chapter II, will minimize or prevent chemical contamination to action area waters with the exception of the Non-native Invasive Plant Control category, which will be described in section d. below. Therefore the following analysis will focus on activity impacts to the Turbidity Indicator.

Short-term inputs of sediment could result from instream structure placement, opening of side channels, road treatments, and other projects that occur inside the bankfull channel. Other sources of sediment will arise from disturbed and exposed ground adjacent to stream channels created by heavy equipment use and moderate-severity controlled burns. The sediment plume will be most concentrated in the immediate project vicinity and should dissipate within a few hours. The amount, extent, and duration of fine sediment inputs and turbidity are related to the following: type and duration of heavy machinery used in or near a bankfull channel; soil type; the amount of soil disturbance; the sensitivity of the channel banks to erosion and other disturbances; the amount of time it takes for disturbed areas to re-vegetate and stabilize; and the probability of precipitation events before disturbed areas are re-vegetated or stabilized.

The increased stream turbidity may deposit fine coats of sediment on channel substrate a short distance downstream, encourage fish to move downstream, and alter fish behavior patterns for a short time. Because the work will be conducted during the in-water work periods (a time when spawning is not expected and after emergence of fry), the project should not interfere with spawning, egg development, and the sac fry life stage. In cases of fall-spawning fish, the fine layer of sediment deposited on channel substrate will be cleared away as the fish construct redds. It is anticipated that all project related sediment will be flushed out during the first fall/winter/spring high flows after project completion, and site restoration conservation measures are expected to prevent future project related sediment inputs into the stream. Therefore, long-term impacts to turbidity and spawning gravels are not expected.

d. **Short-term Negative Impacts of the ARBA II Non-Native Invasive Plant Control and Sudden Oak Death Treatment categories to the Water Quality Pathway**

i. **Temperature**

(a) Non-Native Invasive Plant Control – Most mechanical and herbicidal treatments of invasive plant species in riparian areas are not likely to decrease shading of streams. However, in some situations, decreased shading is likely to result, increasing the amount of incident solar radiation reaching the stream. Project design criteria, however, will limit shade reduction to such a degree that increases in water temperature are unlikely. The loss of any shade would persist until native vegetation reaches and surpasses the height of the invasive plants that were removed.

Therefore, this programmatic activity will move the baseline for this indicator towards a “Restore” rating by allowing reestablishment of conifers and other shade producing vegetation in areas currently infested by invasive plants.

(b) Sudden Oak Death Treatment – Mechanical and Manual Treatment and Herbicide Treatment can remove significant amounts (greater than or equal to 5% per 2000 meters of contiguous perennial stream within a watershed) of canopy within the primary and secondary shade zone and result in significant negative (-) elevations of stream temperatures that are measurable and detectable. Project design criteria, however, limit the amount of vegetation removal as to minimize temperature increases.

ii. **Turbidity**

(a) Non-Native Invasive Plant Control – Next, one of the criteria for selecting the invasive plant treatment methods included in this program was their low potential for creating ground disturbance and resulting stream turbidity. Ground disturbance of an extent that may cause localized increases in fine sediment deposition or turbidity is likely to occur only under some circumstances. Hand pulling of emergent vegetation is likely to result in localized turbidity and mobilization of fine sediments.

Hand pulling or site preparation (for replanting) that is extensive, intensive, and immediately adjacent to a stream course could plausibly cause localized instream fine sediment or turbidity increases. However, hand pulling or site preparation of a magnitude likely to generate biologically relevant sediment and turbidity increases is not likely to occur due to the difficulty in treating large sites by hand.

Biological controls typically work slowly over a period of years, and only on target species, and are thus unlikely to lead to bare ground and surface erosion that would increase fine sediment and turbidity.

Hand pulling of emergent vegetation is likely to result in localized turbidity increases and mobilization of fine sediments. The degree of effect will be proportionate to the extent of the infestation treated, type of substrate in which the plants are rooted, rooting depth, whether a hand tool is required for pulling (weed wrench, shovel, etc.), and similar factors. Some hand pulling treatments could result in short-term adverse effects to listed fish in the vicinity of the treatment area.

Other manual, mechanical, solarization, and herbicide (cut-stump, and wicking/wiping) treatment methods are unlikely to cause fine sediment or turbidity increases. Seed clipping, stabbing, girdling, and cutting typically do not involve ground disturbance or result in bare ground. Solarization may result in bare ground, but is typically small-scale, treating less than 0.1 acres at a time at individual sites. Treatment of knotweed and other streamside invasive species with herbicides (by stem injection or spot spray) or heavy machinery is likely to result in biologically relevant, short-term increases in fine sediment deposition or turbidity when treatment of locally extensive streamside monocultures occurs.

Riparian area invasive plant treatment will be conducted in a manner as to “Maintain” current turbidity conditions. As discussed above, localized short-term effects are likely to result only from herbicide or mechanical treatment of locally extensive streamside monocultures. On occasion, hand pulling techniques could result in short-term effects.

(b) Sudden Oak Death Treatment – Hand pile and broadcast burn treatments within the riparian area will create bare ground with the potential to result in sediment inputs into stream channels through overland flow from burn piles or firelines. Site restoration and other PDCs will be implemented to minimize sediment inputs into streams.

iii. Chemical Contamination/Nutrients (Non-Native Invasive Plant Control and Sudden Oak Death Treatments) – Herbicides included in this invasive plant programmatic activity were selected due to their low to moderate aquatic toxicity to listed salmonids. The associated application methods were selected for their low risk of contaminating soils and subsequently introducing herbicides to streams. However, direct and indirect exposure and toxicity risks are inherent in some application scenarios and are discussed below. (The only herbicides proposed for use for Sudden Oak Death Treatment are aquatic-labeled glyphosate and aquatic-labeled imazapyr in accordance with project design criteria for herbicides in aquatic restoration category 13. Non-native Invasive Plant Control, (e) Chemical Methods.)

Only aquatic labeled herbicides are to be applied within wet stream channels. Aquatic glyphosate and aquatic imazapyr can be applied up to the waterline using spot spray or hand selective application methods in both perennial and intermittent channels. Triclopyr TEA and 2,4-D amine can be applied up to the waterline, but only using hand selective techniques. See herbicide buffers (Table 6).

Aquatic labeled glyphosate and imazapyr are the only herbicides to be used for treatment of emergent knotweed. Treatment will primarily be by spot spray (including back-pack spraying) or wicking/wiping. Stem injection techniques may also be used on small infestations where there is reduced risk of exceeding label rates.

Analysis conducted for the USFS Region 6 Invasive Plant EIS BA (USFS 2005) and the Vegetation Treatments Using Herbicides on BLM Lands in 17 Western States EIS (BLM 2007) characterized the risk associated with the above listed herbicides to listed aquatic species.

Under the application scenario analyzed in the USFS Region 6 BA, chlorsulfuron, clopyralid, metsulfuron methyl, imazapyr and sulfometuron methyl were not identified as posing a significant risk of causing sub-lethal effects to listed aquatic species. Plausible risk of sub-lethal effects to listed aquatic species under the application scenario modeled for the USFS Regional BA was identified for glyphosate (including aquatic labeled and without surfactant) and sethoxydim.

The risk of adverse effects from the toxicity of herbicides and other compounds present in formulations to listed aquatic species is mitigated in this programmatic activity by reducing stream delivery potential by restricting application methods. Cut-stump, hack & squirt, stem injection, and wicking/wiping applications occurring outside of stream channels have a low potential for delivering herbicides to soils, where they would be available for leaching into streams. In addition, glyphosate generally has low soil mobility due to high sorption to soil particles. Based on extrapolation of hazard quotient calculations from the USFS Regional BA and water contamination rates from the SERA risk assessments, adverse effects to water quality from cut-stump, hack & squirt, stem injection, and wicking/wiping applications occurring outside of stream channels are not likely to occur. In addition to APDC mitigations, the combination of lower amounts of herbicide contacting soil (the USFS and SERA analyses assumed broadcast spray application) and likelihood of lower application rates (due to more efficient application) will reduce the amount of herbicide delivered into streams.

The toxicity risk for listed fish species identified in the USFS Region 6 BA for glyphosate application was due to high broadcast application rates allowed by the label, rather than high glyphosate toxicity. The acute toxicity of aquatic labeled glyphosate is classified as “slightly/moderately toxic”. Recently, high application rates of glyphosate used in stem injection have been thought to result in introduction to streams, either from leakage from roots or release during the decay of the plants. Spot spray treatment of knotweed plants immediately adjacent to or emergent from streams is likely to result in some introduction of glyphosate to streams, although in lower amounts than stem injection.

The toxicity risk for listed fish species identified in the USFS Region 6 BA for sethoxydim is primarily due to the presence of naphtha solvent in the formulated product (Poast). The Poast formulation containing the naphtha solvent is approximately 200 times more toxic than sethoxydim alone (SERA 2001). The acute toxicity of sethoxydim alone is classified as “practically non-toxic” (LC50 value of 265 mg/l), whereas the acute toxicity of the formulated product (Poast) is classified as “moderately toxic” (LC50 value of 1.2 mg/l). Mitigations included in the invasive plant activity description are designed to allow the naphtha solvent to volatilize, markedly reducing its’ availability for delivery to streams.

Banvel - "Dicamba is not registered for use in aquatic environments. The Ecological Risk Assessment shows a low risk to susceptible fish under the spill scenario at the maximum rate and no risk to fish under other exposure scenarios. Off-site drift and surface runoff of dicamba also present no risk to fish. (Vegetation Treatments Using Herbicides on BLM Lands in Oregon EIS July 2010 p.226.)

Overdrive- Dicamba + Diflufenzopyr "Diflufenzopyr + dicamba is a selective, systemic herbicide with low residence times in water bodies and a low bio-concentration potential (National Library of Medicine 2002). Diflufenzopyr + dicamba application does not pose a risk to fish under any application scenario (see toxicity studies under dicamba and diflufenzopyr" (Vegetation Treatments Using Herbicides on BLM Lands in Oregon EIS July 2010 p.225.). "The Ecological Risk Assessment shows that diflufenzopyr does not pose a risk to fish under any of the Ecological Risk Scenarios" (Vegetation Treatments Using Herbicides on BLM Lands in Oregon EIS July 2010 p.224.).

There is a greater than discountable risk of indirect introduction of herbicides to streams containing ESA-listed fish and their designated critical habitat resulting from herbicide applications that occur within the bankfull width of tributary intermittent channels. The APDC allow applications of herbicides at maximum label rates within intermittent channels by spot spray, cut-stump, hack & squirt, and wicking/wiping. Given the programmatic nature of this activity and extensive geographic coverage, it is likely that circumstances will arise where substantial treatment of invasive plant infestations occurs within intermittent or ephemeral channels tributary to streams with ESA-listed fish and their designated critical habitat. According to the “first flush” phenomenon described by Caltrans (2005), the highest concentration of herbicide occurs in the first storm event following application. The highest concentration occurs when the flow in the channel is low compared to later in the storm runoff event. Since instream herbicide concentrations (and thus hazard quotients) are potentially high for the initial runoff in these “first flush” events in some situations, but cannot currently be calculated (due to unknown site conditions), some level of adverse effects to fish present at intermittent/occupied perennial stream confluences is considered likely to occur.

The treatment methods included in this activity description are generally only appropriate for invasive plant treatments of small to moderate size and intensity, and increased inputs of nutrients to streams from decaying plants sufficient to significantly affect listed fish are not likely to occur.

Riparian area invasive plant treatment will be conducted in a manner as to “Maintain” long-term water quality with respect to chemical contamination and nutrients, with limited short-term adverse effects. As discussed above, the combination of application methods, low toxicity herbicides, and PDC are likely to restrict adverse effects from herbicide exposures on listed fish to infrequent, short-term occurrences.

2. **Habitat Access Pathway**

a. Indicator Description – The description of the following pathway indicator provides the ways in which it serves as an essential ecological function necessary for the overall viability of fish stocks: Physical Barrier.

i. **Physical Barriers –** Human constructed physical barriers within the stream channel, such as culverts, headcuts, irrigation weirs, and dams can impair sediment and debris transport, migration routes, life history patterns, and population viability. First and second order streams, which generally include permanently flowing non-fish bearing streams and seasonally flowing or intermittent streams, often comprise over 70 percent of the cumulative channel length in mountain watersheds in the Pacific Northwest (Benda et al. 1992). These streams are the sources of water, nutrients, wood, and other vegetative material for streams inhabited by fish and other aquatic organisms (Swanson et al. 1982; Benda and Zhanag 1990). Decoupling the stream network (through physical barriers) can result in the disruption and loss of functions and processes necessary for creating and maintaining fish habitat. Further, physical barriers prevent the movement of fish in their fulfillment of life history functions. Culverts, for instance, prevent juvenile fish from reaching rearing habitats (Furniss et al. 1991) and have blocked significant amounts of historical anadromous salmonid habitat (Roni et al. 2002; Sheer and Steel 2006). Even more, barriers restrict the expression of various life history forms within a species. Migratory movements of fluvial or adfluvial forms of bull trout, for example, can be restricted or prevented, and such a loss of life history forms restricts the full potential of fish production. Finally, strong populations rely on unimpeded access between watershed reserves, those areas of high quality habitat occupied by viable subpopulations, for dispersion and genetic interchange (Noss et al. 1997).

b. **Long-term Benefits of ARBA II Activities to the Habitat Access Pathway –** Two ARBA II activity categories, both of which contain subcategories, will restore fish passage into previously occupied habitat for all life stages of native fish. The Fish Passage Restoration category contains four sub-categories: Fish Passage Culvert and Bridge Projects; Headcut Stabilization and Associated Fish Passage; Fish Ladders; Irrigation Diversion Replacement/Relocation & Screen Installation/Replacement. The Dam, Tidegate, and Legacy Structure Removal category contains two subcategories that will target fish passage restoration: Dam and Tidegate removal. The resulting benefits include uninhibited stream access for migrating and rearing fish, restored or improved continuous paths for wood, nutrients, sediments, and other vegetative material essential for quality fish habitat.

c. **Short-term Negative Impacts of ARBA II Activities to the Habitat Access Pathway –** As described above, ARBA II activity categories are expected to benefit Habitat Access. In acquiring this benefit, short-term negative impacts are expected. Such impacts will be minimized by incorporating ACMs and PDCs described in Chapter II into project design, implementation, and monitoring.

The ARBA II Team determined that the aforementioned activities described above may temporarily restrict habitat access during project implementation. Coffer dams and water bypass systems associated with these activities may temporarily block (few weeks) fish movement up and/or downstream through the construction area. Up and downstream fish movement will be permitted with ditch bypass systems, downstream fish movement is provided with plastic-culvert bypass structures, and no fish movement is provided with pump bypass systems. Because road crossings, dams, irrigation diversions, tidegates, and headcuts to be repaired serve as existing fish-passage barriers, coffer dams and diversion structures may not be any more of a barrier than the pre-restoration baseline. The remaining activity types are not expected to result in barriers to fish movement during any life stages and will therefore have no negative impacts to this indicator.

3. Habitat Elements Pathway

a. **Indicator Description –** Descriptions of the following five indicators provide the ways in which each indicator serves as an essential ecological function necessary for the overall viability of fish stocks: Substrate/Sediment; Large Wood; Pool Frequency and Quality; Off-channel Habitat; Refugia.

i. **Substrate/Sediment** (excerpts from Rieman and McIntyre 1993) – This indicator is similar to "Sediment" in that it addresses fines and their effects on fish habitat. Unlike "Sediment," which addresses spawning and incubation, the substrate indicator assesses fines and their effects on rearing habitat within channel substrate. The NMFS (1996) notes that rearing capacity of salmon habitat decreases as cobble embeddedness levels increase, resulting from increased sedimentation. Furthermore, over wintering rearing habitat within substrate may be a limiting factor to fish production and survival, and the loss of this over wintering habitat may result in increased levels of mortality during rearing life stages. Likewise, when the percent of fine sediments in the substrate was relatively high, rearing bull trout were also less abundant.

Preferred spawning areas in rivers or streams for Lost River (USFWS 2007a), Shortnose (USFWS 2007b), and Modoc (Mills 1980) suckers are dominated by clean gravel-sized substrate while Warner suckers can spawn in either sand or gravel dominated substrate (USDI 1998C).

ii. **Large Wood (LW) –** Large wood in streams is an important roughness element influencing channel morphology, sediment distribution, and water routing (Swanson and Lienkaemper 1978; Bisson et al. 1987). Common sources of large wood include falling of dead trees, wind-throw and breakage, and landslides (Johnston et al. 2011). Latterell and Naiman (2007) observed that the primary source of in-stream wood on the Queets River in Washington was from channel meandering and bank erosion through riparian areas. Large wood influences channel gradient by creating step pools and dissipating energy (Heede 1985), lengthens streams by increasing sinuosity (Swanston 1991), and serves as an important agent in pool formation (Montgomery et al.1995; Reeves et al.

2011). In low order streams, in particular, LW collects sediment and larger substrates during high flow events (Keller et al. 1985) and can account for 50% of the sediment/substrate storage sites (Megahan 1982). Further, LW is instrumental in nutrient retention by capturing and storing salmon carcasses (Cederholm and Peterson 1985; Strobel et al. 2009) and allochthonous materials, a primary energy source for smaller rivers and streams (Gregory et al. 1991). The resulting effect of LW on fish habitat is significant. Crispin et al. (1993) noted increased salmon spawning activity in an area where gravels accumulated behind LW. Bjornn and Reiser (1991) cited several studies that documented an increase in fish densities with higher levels of LW, and Fausch and Northcote (1992) documented that Coho salmon and cutthroat trout production was greater in LW-dominated streams, where pools, sinuosity, and overhead cover were greatest. The Modoc (USFWS 2009) and Warner (USDI 1998c) suckers rely on large wood and rootwads for cover in pool habitat. The role of LW decreases as streams become larger, because greater currents will carry LW out of the active channel and onto the banks (Murphy and Meehan 1991).

iii. **Pool Frequency and Quality –** Pools are considered to be one of the most important habitat elements and are the preferred habitat type by most fish (Bestcha and Platts 1986), offering low velocity refuges, cooler stream temperatures during summer months, and overwintering habitat (Reeves et al. 1991). Salmonid density is positively correlated to pool volume and frequency; pool loss reduces the production capability of salmonid habitat (Everest et al. 1985; Sedell and Everest 1990; MacDonald et al. 1991; Nickelson et al. 1992a; Fausch and Northcote 1992; Reeves et al. 2011). Further, not only do stream-type suckers use pools for holding and rearing (Mills 1980; USDI 1998C; USFWS 2009), the Modoc (Mills 1980) and Warner (USDI 1998C) rely on pool habitat for spawning.

Availability of pools during summer low flow periods can be a limiting factor in survival and production of salmonids (Reeves et al., 1990). In reference to spawning, pool tailouts, where gravel is deposited, are important areas for redd construction, and the pool bodies provide rearing habitat for juveniles and holding habitat for adults (Bjornn and Reiser 1991). Further, Sedell et al. (1990) describes pools as being important refuges from drought, fire, winter icing, and other disturbances. When pool numbers, volume, depth, and complexity increase, the stream's capacity to support a diversity of species and life stages increases (Bisson et al. 1992; Bjornn and Reiser 1991). In general, pool quality is directly related to decreased surface area and increased depth, overhead cover (Fausch and Northcote 1992), presence of LW, and undercut banks, especially in lower gradient streams. Further, pools of all shapes and sizes are needed to accommodate the various life history stages of fish, thereby allowing for juveniles to occupy pools absent of larger predatory fish (Bestcha and Platts 1986).

iv. **Off-channel Habitat –** Off-channel habitats—comprised of alcoves, side channels, freshwater sloughs, wetlands or other seasonally or permanently flooded areas—are important rearing sites for juvenile fish (Roni et al. 2002). Roni et al. (2002) noted that most off channel habitat research focused on coho salmon, noting that juveniles are much more reliant on this habitat type for over-winter rearing and growth than other salmonids, such as cutthroat trout and Chinook salmon. In an Oregon coastal stream, Reeves et al. (2011) noted that side channels comprised 5% of the total habitat but contained 20-60% of the coho fry in the study area. Likewise, Warner sucker larvae prefer backwater pools, often among or near macrophytes (USDI 1998C).

v. **Refugia –** Refugia, or designated areas providing high quality habitat, either currently or in the future, are a cornerstone of most species conservation strategies. Although fragmented areas of suitable habitat may be important, Moyle and Sato (1991) argue that to recover aquatic species, refugia should be focused at a watershed scale. Naiman et al. (1992) and Sheldon (1998) noted that past attempts to recover fish populations were unsuccessful because the problem was not approached from a watershed perspective. Noss et al. (1997) provides additional information, listing several principals that should be considered when evaluating reserves (refugia). First, refugia should be well distributed across a landscape, the idea being that widely distributed subpopulations will not experience catastrophic or adverse impacts across its entire range. Some subpopulations will escape the impact, eventually re-colonize the affected area, and sustain the population as a whole. Second, large reserves are better than small ones, because there is a greater opportunity for habitat diversity and larger population size. As a result, genetic variability within a population will be optimized, promoting increased adaptability to environmental change. Thirdly, refugia that are closer together are better than those farther apart. A short distance between refugia promotes dispersion and genetic interchange. If enough interchange occurs between refugia, fish are functionally united into a larger population that can better avoid extinction.

b. Long-term Benefits of ARBA II Activities to the Habitat Elements Pathway – The following ARBA II activity categories will provide immediate and long-term benefits to one or more of the Habitat Element indicators: Fish Passage Restoration; Large Wood, Boulder, and Gravel Placement; Dam, Tidegate, and Legacy Structure Removal; Channel Reconstruction/Relocation; Streambank Restoration; Set-back or Removal of Existing Berms, Dikes, and Levees; Reduction/Relocation of Recreation Impacts; Piling and other Structure Removal; Road and Trail Erosion Control and Decommissioning. Other ARBA II activity categories may not provide immediate benefits but will provide long-term benefits: Non-native Invasive Plant Control; Juniper Removal; Riparian Vegetation Treatment (controlled burning); Riparian Vegetative Planting; Beaver Habitat Restoration; Sudden Oak Death Treatments.

For instance, large wood and boulder placement will enhance habitat elements described in the Large Wood indicator, while Reconnection of Existing Side Channels and Alcoves will increase adult and juvenile rearing habitat as described in the Off-channel Habitat indicator above. Headcut stabilization, bank restoration, and road treatment projects will decrease direct sediment inputs into the stream channel, thereby enhancing conditions for juvenile rearing within channel substrate. Fish Passage Restoration projects will provide access to refugia while all restoration actions within this ARBA II will enhance the quality of such refugia.

c. **Short-term Negative Impacts of ARBA II Activities to the Habitat Element Pathway –** As described above, ARBA II activity categories are expected to benefit Habitat Element indicators. In acquiring these benefits, short-term negative impacts are expected. Such impacts will be minimized by incorporating ACMs and PDCs described in Chapter II into project design, implementation, and monitoring.

   The ARBA II Team determined that negative impacts would occur to Substrate/Sediment. Further, the Team determined that all activity categories are known to increase short-term sediment loads into a stream channel during project implementation. Increased sediment loads would result from the use of large equipment within or adjacent to a stream channel, causing soil disturbance and transport within the stream system. The ARBA II Team also concluded that these activities are unlikely to have negative impacts to the remaining indicators of this pathway as ARBA II projects are intended to enhance such indicators. Therefore the following analysis will focus on activity affects to the Substrate/Sediment indicator.

   Short-term inputs of sediment could result from instream structure placement, opening of side channels, road treatments, and other projects that occur inside or near the bankfull channel. Treatment of knotweed and other streamside invasive species with herbicides (by stem injection or spot spray) or heavy machinery is likely to result in biologically relevant, short-term increases in fine sediment deposition or turbidity when treatment of locally extensive streamside monocultures occurs. The sediment plume from activities will be most concentrated in the immediate project vicinity and should dissipate throughout a stream channel within a few hours. The amount, extent, and duration of fine sediment inputs and turbidity are related to the following: the type and duration of heavy machinery used within or near a bankfull channel; soil type; the amount of soil disturbance; whether restoration is in or out of the wetted channel; the sensitivity of the channel banks to erosion and other disturbances; the amount of time it takes for disturbed areas to re-vegetate and stabilize; and the probability of precipitation events before disturbed areas are re-vegetated or stabilized.

   The increased stream turbidity may deposit fine coats of sediment on channel substrate a short distance downstream, encourage fish to move downstream, and alter behavior patterns for a short time. Because the work will be conducted during the in-water work periods (a time when spawning is not expected and after emergence of fry), the project should not interfere with spawning, egg development, and the sac fry life stage. In cases of fall-spawning fish, the fine layer of sediment deposited on channel substrate will be cleared away as the fish construct their redds. It is anticipated that all project related sediment will be flushed out during the first fall/winter/spring high flows after project completion, and site restoration conservation measures are expected to prevent future project related sediment inputs into the stream. Therefore, long-term negative impacts to Substrate/Sediment are not expected.

4. **Channel Conditions and Dynamics Pathway**
   a. **Indicator Description –** The descriptions of the following three pathway indicators provide the ways in which each indicator serves as an essential ecological function necessary for the overall viability of fish stocks: Width/Depth Ratio; Streambank Condition; Floodplain Connectivity.
      i. **Width/Depth Ratios –** The width to depth ratio is an index value that helps describe the shape of a stream channel, and is the ratio of bankfull width to mean bankfull depth (Rosgen 1996). Both measurements are based on bankfull flow or its indicators. In short, bankfull flow is the channel forming flow that transports the bulk of available sediment over time. In another way, bankfull flows are those that transport sediment from upstream reaches, forming and removing channel bars, doing the work that forms the morphological characteristics of a channel (Dunne and Leopold 1978). Relatively small width/ depth values are indicative of stream stability, and Rosgen (1996) suggests that width to depth ratios can be used as a surrogate to stream stability. Finally, Bestcha and Platts (1986) state that as width to depth ratios increase, the stream becomes shallower and may result in a loss of pools.
      ii. **Streambank Condition –** Streambank condition is related to its ability to dissipate stream power. For many stream channels, riparian vegetation with woody root masses, along with instream debris, serve as physical barriers to erosive and downcutting forces of stream power (Bestcha and Platts 1986). Further, the stems of herbaceous and woody plants, residing on the stream bank, provide additional roughness to dissipate stream power and capture suspended sediments (Elmore and Bestcha 1987). When these roughness elements are removed, however, a streambanks ability to withstand stream power is decreased, resulting in bank erosion, relatively higher width to depth ratios, and possible channel incision. Even if streambanks are in good condition, increased peak flows can damage banks and cause channel incision. Finally, streambanks that are in good condition can provide quality fish habitat through undercut banks and overhanging vegetation (Bestcha and Platts 1986; USDI 1998c).
      iii. **Floodplain Connectivity –** Leopold (1994) defines a floodplain as a level area near a river channel, constructed by the river in the present climate and overland flow during moderate flow events. When a stream can readily access its floodplain during high flow events, the stream will

overflow its banks and spread across the floodplain, dissipating stream energy, depositing sediments, accessing side channels. Bestcha and Platts (1986) suggest that for a floodplain to be effective in sorting and capturing flood-born sediment it must have roughness elements, such as trees and other debris. Floodplains or riparian areas adjacent to stream channels serve as water storage sites—water collected from flooding and precipitation—which can increase subsurface flow to the stream channel (Elmore and Bestcha 1987), especially important to augmentation of low stream flows during summer months. Likewise, Tonina and Buffington (2009) note that floodplains that are connected to stream channels result in hyporheic exchange of water, resulting in increased nutrient distribution and increased inundation of floodplain habitats, such as side channels, a habitat type offering refuge to juvenile salmonids during high flow events (Roni et al. 2002).

b. Long-term Benefits of ARBA II Activities to the Channel Condition and Dynamics Pathway – All projects will enhance one or more of the indicators under the Channel Condition and Dynamics Pathway. Each of these projects will occur within the bankfull channel and/or immediate floodplain area and are intended to restore channel, bank, and floodplain areas to more natural conditions. As a result, ARBA II projects are expected to decrease width/depth ratios, improve streambank condition, and/or increase floodplain connectivity.

c. Short-term Negative Impacts of ARBA II Activities to the Channel Condition and Dynamics Pathway – As described above, ARBA II activity categories are expected to benefit Channel Conditions and Dynamics. In acquiring these benefits, the ARBA II Team determined that activity categories will not result in negative impacts to any of the three pathway indicators as no projects will increase width/depth ratios, decrease streambank condition, and disconnect floodplains.

5. Flow Hydrology Pathway

a. **Indicator Descriptions –** The descriptions of the following two pathway indicators provide the ways in which each indicator serves as an essential ecological function necessary for the overall viability of fish stocks: Changes in Peak/Base Flows and Increase in Drainage Network.

i. **Changes in Peak/Base Flows** – Many riparian wetlands, such as wet meadows, have been damaged by grazing, mining, road construction, and logging in the analysis area as consistently indicated by field reviews (Beschta et al., 1991). This loss of wetland function has probably contributed to a reduction in summer low flows relative to historic conditions. Although data are sparse, peakflows may occur a week or two earlier in the year in some managed watersheds year than in unmanaged watersheds. McIntosh (1992) found that the annual peakflows currently occur about 2 weeks earlier in the Grande Ronde than historically. Some heavily logged drainages may have increased summer low flows; summer low flow has increased in the some parts of the Grande Ronde over the past 50 years (McIntosh, 1992). However, the increases in low flows do not appear to have improved salmonid survival because the water quality is so poor and stream habitats have been heavily degraded due to upstream logging, grazing, and road construction (Anderson et al., 1993; McIntosh et al., 1994).

ii. **Increase in Drainage Network –** Wemple et al. (1996) documented that 57% of a road system within a watershed, located in the western Cascades of Oregon, was hydrologically connected to the stream network by roadside ditches draining directly into streams and roadside ditches draining into relief culverts with gullies below their outlets. Thus, an increase in road densities led to an associated increase in drainage density by up to 50%. High-density road systems have been linked to changes in the hydrograph or magnitude and timing of flow events. For instance, in an Oregon Coast Range watershed, Harr et al. (1975) showed that peak flows increased significantly after road building converted at least 12% of the area to road prisms. The causal effects were attributed to increased surface compaction, which reduces water infiltration, resulting in excess water being carried down the road, drainage ditches, and relief culverts into the stream network. Jones and Grant (1996) documented that peak flows increased by 50% in a watershed within a five year period following road construction and logging. The longevity of the hydrologic changes are as permanent as the roads, and until a road is removed and natural drainage patterns are restored, the road will continue to affect the routing of water through a watershed.

b. Long-term Benefits of ARBA II Activities to the Flow/Hydrology Pathway – Numerous ARBA II activity categories will provide immediate benefits to the Flow/Hydrology Pathway: Large Wood, Boulder, and Gravel Placement; Channel Reconstruction/Relocation; Off- and Side-Channel Habitat Restoration; Set-back or Removal of Existing Berms, Dikes, and Levees. Each of these projects will enhance floodplain connectivity, thereby addressing wetland functions described under Peak/base Flows above. Road and Trail Erosion Control and Decommissioning will provide additional benefits in that they will reduce the drainage network, thus addressing issues discussed in the Drainage Network category above.

c. Short-term Negative Impacts of ARBA II Activities to the Flow Hydrology Pathway – As described above, ARBA II activity categories are expected to benefit Peak/base Flows and Drainage Network categories. In acquiring these benefits, the ARBA II Team determined that ARBA II activity categories will not result in negative impacts to any of the two pathway indicators as no projects will not disrupt natural peak/base flow patterns or increase the drainage network.

6. Watershed Condition Pathway

a. **Indicator Description** – The descriptions of the following three MPI Indicators provide the ways in which each indicator serves as an essential ecological function necessary for the overall viability of fish stocks: Road Density and Location, Riparian Reserves, and Disturbance History.

i. **Road Density and Location –** Available information consistently indicates that roads are one of the greatest sources of habitat degradation in managed watersheds, especially when they are within riparian zones (Geppert et al., 1984; Furniss et al., 1991). Roads significantly elevate on-site erosion and sediment delivery for the life of the road (Geppert et al. 1984). Studies consistently indicate that roads increase the frequency of mass failures in mountainous terrain (Dunne and Leopold, 1978; Geppert et al., 1984; Furniss et al. 1991). Mass failure volumes from roads are orders of magnitude greater than from undisturbed areas on a per unit area basis (Dunne and Leopold, 1978; Geppert et al., 1984; Furniss et al., 1991). Road crossings cause extreme increases in sediment delivery (Fowler et al., 1987). Roads also disrupt subsurface flows (Megahan, 1972). Roads increase peakflows (King and Tennyson 1984). Roads within riparian zones reduce shading and disrupt LWD sources for the life of the road. These effects of roads degrade habitat by increasing fine sediment levels, reducing pool volumes, increasing channel width and exacerbating seasonal temperature extremes.

ii. **Riparian Areas –** The following discussion was adapted from FEMAT (1993). Riparian areas are those portions of watersheds that are directly coupled to streams and rivers, the portions of watersheds required for maintaining hydrologic, geomorphic, and ecological processes that directly affect streams, stream processes, and fish habitats. The network of Riparian Reserves—comprised of all stream orders both intermittent and perennial—allow for connectivity of the aquatic ecosystem within a watershed. Riparian areas are shaped by disturbances characteristic of upland ecosystems, such as fire and windthrow, as well as disturbance processes unique to stream systems, such as lateral channel erosion, peakflows, deposition by floods and debris flows. The near-stream riparian areas—floodplains—may contain an increased diversity of plant species and extensive hydrologic nutrient cycling interactions between groundwater and riparian vegetation. This vegetation, ranging from conifers to deciduous hardwoods, provides allochthonous (organic debris) to stream channels and associated aquatic invertebrate communities. Further, riparian vegetation moderates light levels and stream temperature, helps armor stream banks with extensive root systems, and contributes large wood into the stream channel.

iii. **Disturbance History –** Information for this section was acquired from Reeves et al. (1995). Even though the article was directed at anadromous salmonids, the discussion can readily apply to most PNW fish stocks. Riverine-riparian ecosystems within the PNW used by anadromous salmonids naturally experience periodic catastrophic disturbances, which then moved through a series of recovery states over a period of decades to centuries, resulting in a landscape that varies in suitability for salmonids. Disturbance can be categorized as being pulse or press disturbances. A pulse disturbance is one that allows an ecosystem to recover to pre-disturbance conditions, and a press disturbance is one that prohibits an ecosystem from rebounding to pre-disturbance conditions. The dominant pulse disturbances in which the PNW salmonids are adapted to include natural fire regimes, fire related landslides, and floods, all working in concert in a manner that produce habitat patches, varying in quality and quantity. In short, fires would burn through an area, landslides would then transport wood and sediment into the streams, and floods would distribute the sediment and debris throughout stream networks. In the Oregon coast range, the amount of sediment and large wood found in streams could be correlated to occurrence of the last stand replacement fire. This pulse disturbance regime, or varying forms thereof, was altered with the onset of fire suppression and extensive timber harvest. The resulting effects are different from the natural pulse regime in that sediment is transported in the system without wood, the interval between disturbances has been drastically reduced in most cases, and harvest and road construction is widely distributed, resulting in chronic sedimentation across a larger landscape.

b. **Long-term Benefits of ARBA II Activities to the Watershed Condition Pathway –** Several activity categories are expected to provide immediate and long-term benefits to the Watershed Condition Pathway: Dam, Tidegate, and Legacy Structure Removal; Channel Reconstruction/Relocation; Off- and Side-Channel Habitat Restoration; Streambank Restoration; Set-back or Removal of Existing Berms, Dikes, and Levees; Livestock Fencing, Stream Crossings and Off-Channel Livestock Watering; Road and Trail Erosion Control and Decommissioning. Other ARBA II activity categories may not provide immediate benefits but will provide long-term benefits: Non-native Invasive Plant Control; Juniper Removal; Riparian Vegetation Treatment (controlled burning); Riparian Vegetative Planting; Beaver Habitat Restoration; Sudden Oak Death Treatments.

   All of these activities will promote growth of riparian vegetation, thus improving riparian conditions as described under the Riparian Area category. Road treatment projects will reduce the potential for negative impacts as described in the Road Density and Location category as well as restoring processes that would occur under a more natural disturbance regime. Riparian Vegetation Treatment (controlled burning) is intended to mimic and promote the recovery of fire-based natural disturbance regimes, while Road and Trail Erosion Control and Decommissioning projects will help transform disturbance regimes from a press to a pulse regime.

c. **Short-term Negative Impacts of ARBA II Activities to the Watershed Conditions Pathway** –ARBA II activity categories are expected to benefit Watershed Condition indicators. In acquiring these benefits, the ARBA II Team determined that the Sudden Oak Death Treatments category will result in negative impacts to the Riparian Reserve indicator. As described under the Temperature indicator, SOD treatments can reduce riparian canopy cover to such an extent that stream temperatures can increase. As a result, the capability of Riparian Reserves to produce quality aquatic habitats will be reduced. For the remaining 19 ARBA II activity categories, no adverse effects are expected to occur to the three indicators as no projects will increase road density, increase press disturbance regime processes, or degrade riparian conditions.

7. **Fish Population Characteristics**
   a. **Indicator Description –** The descriptions of the following MPI provides the way in which the indicator serves as an essential ecological function necessary for the overall viability of fish stocks.
      i. **Fish Population Characteristics –** There are four key elements of bull trout subpopulations that the USFWS considers important in evaluating subpopulation trends and the likelihood for species persistence at the watershed scale. Subpopulation size is evaluated relative to the habitat capacity and overall demographics (balanced representation of all life stages) to assess the reproductive potential of a subpopulation. Subpopulation growth and survival are evaluated to characterize the relative resilience and likelihood of recovery of a subpopulation from a disturbance that reduces the subpopulation size. The life history diversity (presence of migratory life history) and isolation characteristics of a subpopulation are evaluated to ensure the connectivity between adjacent subpopulations. Finally, subpopulation persistence and genetic integrity is evaluated by considering the risk of hybridization (gene introgression) and the previous assessments of subpopulation size, growth and survival, and life history diversity and isolation characteristics.
   b. **Long-term Benefits of ARBA II Activities to the Fish Pathway** – All ARBA II activities are intended to improve or restore aquatic habitat forming processes within a watershed as a means to create better habitat for ESA- and/or MSA-listed fish. As a result, habitat capacity will increase at the site-specific and watershed scale. Over time, when numerous 5th field watersheds are enhanced through ARBA II projects, habitat capacity will improve at the sub-basin level—4th field watershed. With this increased capacity at the site, watershed, and sub-basin scale, the likelihood that a subpopulation can survive a natural or anthropogenic disturbance will be enhanced. For instance, if a major disturbance, such as a catastrophic wildfire, occurs in a 5th field watershed, nearby watersheds will continue to provide quality habitat for fish within those areas and possibly fish from the disturbed area.

      Furthermore, the ARBA II activities are expected to promote habitat diversity and convert degraded and simplified aquatic ecosystems to ones that are dynamic and complex. For instance, large wood and boulder placement projects will be directed, in part, at bedrock stream channels—characterized by bedrock substrate, low pool frequencies, and wide, shallow, and straight channels. These projects will result in a variety of channel substrates, increased pool frequencies, decreased width/depth ratios, increased stream sinuosity, improved hiding cover, nutrient retention, and more, all of which promote habitat diversity and genetic diversity within a subpopulation of fish.

The Bull Trout Protection category, which focuses on removal of non-native fish species, will help secure Bull trout populations within the restored watersheds.

Terrestrial habitats will benefit by those restoration activities proposing to restore or enhance riparian and upland areas. These activities will help restore the composition and structural diversity of native plant communities and hydrologic functions in riparian and upslope areas.

c. **Short-term Negative Impacts of ARBA II Activities to the Fish Pathway –** As described above, ARBA II activity categories are expected to benefit the Fish Pathway. In acquiring these benefits, short-term negative impacts are expected. Such impacts will be minimized by incorporating ACMs and PDCs described in Chapter II into project design, implementation, and monitoring.

The impacts of project related Turbidity and Substrate/Sediment were presented in the Water Quality and Habitat Elements pathways, respectively. Only short-term negative impacts are expected. Therefore, sediment/turbidity and other impacts from ARBA II activities should have insignificant effects on subpopulation growth, survival, life history diversity, and genetic integrity.

For all ARBA II activities, fish may be incidentally injured or killed by heavy equipment that operates in or along the stream channel. Several projects—Fish Passage Restoration; Dam, Tidegate, and Legacy Structure Removal; Channel Reconstruction/Relocation—will involve fish salvage that may include isolation, capture, handling, transport, and relocation. Fish handling has the potential to result in fish injury or death. Mortality may be immediate or delayed. Handling of fish increases their stress levels and can cause a variety of injurious conditions, including reduced disease resistance, osmoregulatory problems, decreased growth, decreased reproductive capacity, and increased mortality. There is a potential for a small number (up to five percent) of juvenile fish that are present in the dewatered section to avoid being captured and relocated, and thus die because they remain undetected in stream margins under vegetation, rocks, or gravels. Fish salvage protocols to minimize injury or death to fish are listed in Chapter II.

Projects implemented under the In-channel Nutrient Enhancement category will likely harass fish though carcass placement, especially via helicopter placement, and the degree of harassment will depend on the proximity of the helicopter to the water and amount of carcasses being dropped. Further, projects implemented under the Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration category will involve redd and habitat surveys, which can result in harassment of fish during spawning and other times. Finally, work conducted under the Bull Trout Protection category may incidentally injure or kill ESA-listed fish during removal of non-native fish to help secure Bull trout populations, mainly in headwater streams.

C. Effects on Aquatic Species Critical Habitat and Essential Fish Habitat

A thorough MPI analysis for project effects to aquatic species yields an adequate and effective analysis of project effects to the features and functions of Primary Constituent Elements (PCEs) for CH and EFH. Based on the crosswalk analysis between pertinent MPI indicators and PCEs, effects to PCEs from each of the 20 programmatic activity types are fully consistent with those effects identified for ESA listed fish species. For instance, an ESA “likely to adversely affect” determination based upon an analysis of habitat indicators corresponding to “waters” and “substrate” in the definition for EFH, results in a “may adversely affect” EFH determination. Table 42 provides the crosswalk for salmon and steelhead, Table 43 provides the process for Bull trout, and Table 44 provides a crosswalk for the Lost River and Shortnose suckers. The FWS will assess CH for Warner Sucker and Borax Chub in the subsequent ARBO II (Paul Bridges, USFWS Roseburg Office, pers. comm. January 16, 2013).

Table 42 – Crosswalk between Critical Habitat PCEs and MPI for ESA-listed Salmon Species with Designated or Proposed Critical Habitat*

Primary Constituent Elements	MPI Pathways, Indicators that Crosswalk with PCEs
Spawning Habitat, as defined by water quality, water quantity, substrate	**Pathway:** Water Quality **Indicators:** Temperature, Suspended Sediment, Substrate **Pathway:** Flow/Hydrology **Indicator:**: Change in Peak/Base flows **Pathway:** Habitat Elements **Indicator:** Substrate/Embeddedness
Rearing as defined by adequate water quantity and floodplain connectivity	**Pathway:** Channel Conditions and Dynamics **Indicator:** Floodplain connectivity **Pathway:** Flow/Hydrology **Indicator:** Change in Peak/Base flow
Rearing as defined by adequate water quality and forage	**Pathway:** Water Quality **Indicator:** Temperature, Substrate **Pathway:** Habitat Elements **Indicators:** Large wood, Pool Frequency and Quality, Off-channel Habitat
Rearing as defined by adequate natural cover	**Pathway:** Habitat Elements **Indicators:** Large wood, Pool Frequency and Quality, Large Pools, Off-channel Habitat

Table 42 (continued) – Crosswalk between Critical Habitat PCEs and MPI for ESA-listed Salmon Species with Designated or Proposed Critical Habitat*	
Primary Constituent Elements	**MPI Pathways, Indicators that Crosswalk with PCEs**
Migration as defined by habitat free of artificial obstructions, and adequate water quality, water quantity, and natural cover	**Pathway:** Habitat Access **Indicator:** Physical Barriers **Pathway:** Water Quality **Indicator:** Temperature **Pathway:** Flow/Hydrology **Indicator:** Change in Peak/Base flow **Pathway:** Habitat Elements **Indicators:** Large wood, Pool Frequency and Quality, Large Pools
Estuarine Areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation	**Pathway:** Habitat Access **Indicator:** Physical Barriers **Pathway:** Water Quality **Indicator:** Temperature **Pathway:** Flow/Hydrology **Indicator:** Change in Peak/Base flow **Pathway:** Habitat Elements **Indicators:** Large wood, Pool Frequency and Quality, Large Pools, Off-Channel Habitat; 9) Refugia **Pathway: Channel Condition and Dynamics** **Indicator:** Floodplain Connectivity

* The proposed rule for designation of CH for Lower Columbia River Coho Salmon and Puget Sound Steelhead was issued on January 14, 2013 (50 CFR Part 226, Vol. 78, No. 9, pp. 2726-2796). The proposed PCEs for these species critical habitat are the same as those listed in Table 42, which were identified in 2005 for all other ESA-listed salmon and steelhead covered in this ARBA II (50 CFR Part 226, Vol. 70, No. 170. Sept. 2005, pp. 52684-52685). Therefore, this crosswalk addresses ARBA II effects to proposed CH for Lower Columbia River Coho Salmon and Puget Sound Steelhead.

Table 43 – Crosswalk between Critical Habitat PCEs and MPI for Bull Trout.	
Primary Constituent Element	**MPI Habitat Indicators**
(1) Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.	**Pathway:** Channel Condition and Dynamics **Indicator:** floodplain connectivity **Pathway:** Flow/Hydrology **Indicator:** Change in peak/base flows
2) Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers	**Pathway:** Habitat Access **Indicator:** Physical barriers **Pathway:** Water Quality **Indicator:** Chemical contaminants/nutrients, temperature **Pathway:** Flow/Hydrology **Indicator:** change in peak/base flows
3) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.	**Pathways:** Water Quality, Habitat Elements, Channel Condition and Dynamics, Habitat Access **Indicators:** All associated with these pathways
4) Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates, to provide a variety of depths, gradients, velocities, and structure.	**Pathway:** Habitat Elements **Indicators:** large wood, pool frequency and quality, large pools, off channel habitat, refugia **Pathway:** Channel conditions and Dynamics **Indicators:** wetted width/maximum depth ratio, stream bank condition, floodplain connectivity

Table 43 (continued). Crosswalk between Critical Habitat PCEs and MPI for Bull Trout.

Primary Constituent Element	MPI Habitat Indicators
(**5)** Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shade, such as that provided by riparian habitat; and local groundwater influence.	**Pathway:** Water Quality **Indicator:** temperature
(6) In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.	**Pathway:** Water Quality **Indicator:** sediment **Pathway:** Habitat Elements **Indicator:** substrate embeddedness
(7) A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.	**Pathway: Flow/Hydrology** **Indicator:** change in peak/base flows
(8) Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.	**Pathway:** Water Quality **Indicator:** chemical contamination/nutrients
9) Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.	

Table 44 – Crosswalk between Critical Habitat PCEs and MPI for the Lost River Sucker and Shortnose Sucker.

Primary Constituent Element	MPI Habitat Indicators
(1) Water – Areas with sufficient water quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refugia habitats with minimal physical, biological, or chemical impediments to connectivity. Water should exhibit depths ranging from less than 1.0 m (3.28 ft) up to 4.5 m (14.8 ft) to accommodate each life stage. The water quality characteristics should include water temperatures of less than 28.0 Celsius (82.4 F); pH less than 9.75; dissolved oxygen levels greater than 4.0 mg per L; algal toxins (less than 1.0 microgram (mg) per L); and un-ionized ammonia (less than 0.5 mg per L). Elements also include natural flow regimes that provide flows during the appropriate time of year or, if flows are controlled, minimal flow departure from a natural hydrograph	**Pathway:** Water Quality **Indicator:** Temperature, Chemical Concentration/Nutrients **Pathway:** Habitat Access **Indicator:** Physical barriers **Pathway:** Channel Condition and Dynamics **Indicator:** Floodplain connectivity **Pathway:** Flow/Hydrology **Indicator:** Change in peak/base flows
2) Spawning and Rearing – Streams and shoreline springs with gravel and cobble substrate at depths typically less than 1.3 m (4.3 ft) with adequate stream velocity to allow spawning to occur. Areas identified in PCE1 containing emergent vegetation adjacent to open water that provides habitat for rearing. This facilitates growth and survival of suckers, as well as protection from predation and protection from currents and turbulence	**Pathway:** Water Quality **Indicator:** Temperature, Sediment **Pathway:** Habitat Access **Indicator:** Physical barriers **Pathway:** Habitat Elements **Indicator:** All indicators **Pathway:** Flow/Hydrology **Indicator:** Change in peak/base flows
3) Food – Areas that contain an abundant forage base, including a broad array of chironomidae, crustacea, and other aquatic macroinvertebrates. With this proposed designation of critical habitat, we intend to identify the physical and biological features essential to the conservation of the species, through the identification of the appropriate quantity and spatial arrangement of the primary constituent elements sufficient to support the life history processes of the species.	**Pathways:** Water Quality, Habitat Elements, Channel Condition and Dynamics, Habitat Access **Indicators:** All associated with these pathways

D. Summary and Conclusions for Aquatic Effect Determinations for ARBA II Aquatic Restoration Categories

Refer to Chapter V, section B, for a detailed description of the beneficial effects of the actions. There are no actions that were determined to be solely beneficial. A summary of the negative impacts resulting in conclusions of LAA for effects to ESA-listed fish species, LAA for effects to critical habitat, and "May Adversely Affect" Essential Fish Habitat, are presented below.

1. **ARBA II Project Impacts to Baseline Conditions for Matrix Indicators:** All projects (except for In-channel Nutrient Enhancement and Fisheries, Hydrology, Geomorphology Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration activity categories) will result in negative impacts to the Turbidity and Substrate/Sediment Indicators in proximity to listed fish species and within designated CH. The sediment plume from ARBA II activities will be most concentrated in the immediate project vicinity and should dissipate in the stream channel within in a few hours. The increased stream turbidity may deposit fine coats of sediment on channel substrate a short distance downstream. It is anticipated that all project related sediment will be flushed out during the first fall/winter/spring high flows after project completion, and site restoration conservation measures are expected to prevent future project related sediment inputs into the stream. Therefore, long-term impacts to turbidity and substrate/sediment, including spawning gravels, are not expected.

   Riparian area invasive plant treatment will be conducted in a manner as to "Maintain" long-term water quality with respect to chemical contamination and nutrients, with limited short-term adverse effects. As discussed above, the combination of application methods, low toxicity herbicides, and PDC are likely to restrict adverse effects from herbicide exposures on listed fish to infrequent, short-term occurrences.
2. **ARBA II Project Effects to Individual ESA-listed Fish:** Turbidity plumes will cause fish to move downstream and alter behavior patterns for a short time, and heavy equipment used within the stream channel may incidentally harm, harass, or kill individual fish. Because the work will be conducted during the in-water work periods (a time when spawning is not expected and after emergence of fry), the projects should not interfere with spawning, egg development, and the sac fry life stage. In cases of fall-spawning fish, the fine layer of sediment deposited on channel substrate will be cleared away as the fish construct redds.

   The Fish Passage Restoration, Water Control, Legacy Habitat, and other Structure Removal, and Channel Reconstruction/Relocation categories will involve fish salvage. Fish salvage (isolation, pursuit, capture, and transport) will occur when diverting a stream around a project site to minimize adverse impacts (Fish Passage Restoration; Dam, Tidegate, and Legacy Structure Removal) or when diverting flow from a channelized stream into a newly reconstructed channel (Channel Reconstruction/Relocation). The fish would be captured and placed back into the stream in a secure location. Fish handling has the potential to result in fish injury or death. Mortality may be immediate or delayed. Handling of fish increases their stress levels and can cause a variety of injurious conditions, including reduced disease resistance, osmoregulatory problems, decreased growth, decreased reproductive capacity, and increased mortality. There is a potential for a small number (up to five percent) of juvenile fish that are present in the dewatered section to avoid being captured and relocated, and thus die because they remain undetected in stream margins under vegetation, rocks, or gravels. Fish salvage protocols to minimize injury or death to fish are listed in Chapter II.

Finally, fish may be incidentally harassed, injured or killed during carcass placement, redd and/or habitat surveys, and removal of non-native fish to protect Bull trout populations.

In conclusion, the displacement of fish during sustained periods of turbidity, handling of fish for fish salvage, and potential for incidental take due to project implementation support an effect determination of LAA for the species. Refer to Table 45– ESA Effect Determinations for Listed Fish Species, Designated Critical Habitat, and MSA Effect Determinations for Essential Fish Habitat.

3. **ARBA II Project Effects to Critical Habitat:** The analysis of effects to habitat indicators corresponding to water quality and substrate components of PCEs for anadromous salmonids, Bull trout, and Lost River and Shortnose suckers support an LAA determination for critical habitat for LAA projects. The FWS will assess the CH for Warner Sucker and Borax Chub in the subsequent ARBO II (Paul Bridges, USFWS Roseburg Office, pers. comm. January 16, 2013). Refer to Table 45 – ESA Effect Determinations for Listed Fish Species, Designated Critical Habitat, and MSA Effect Determinations for Essential Fish Habitat.
4. **ARBA II Project Effects to Essential Fish Habitat:** An ESA "likely to adversely affect" determination based upon an analysis of habitat indicators corresponding to "waters" and "substrate" in the definition for EFH, results in a "may adversely affect" EFH determination. Refer to Table 45 – ESA Effect Determinations for Listed Fish Species, Designated Critical Habitat, and MSA Effect Determinations for Essential Fish Habitat.

Table 45 – ESA Effect Determinations for Listed Fish Species, Designated or Proposed Critical Habitat, and MSA Effect Determinations for Essential Fish Habitat

Species	ESA Listing Status	Determination of Effects for LAA Projects		
		Individuals	Critical Habitat	Essential Fish Habitat
Bull Trout	Threatened	LAA	LAA	NA
Lahontan Cutthroat Trout	Threatened	LAA	NA	NA
Lost River Sucker	Endangered	LAA	LAA	NA
Shortnose Sucker	Endangered	LAA	LAA	NA
Warner Sucker	Threatened	LAA	LAA*	NA
Modoc Sucker	Endangered	LAA	NA	NA
Oregon Chub	Endangered	LAA	NA	NA
Borax Chub	Endangered	LAA	LAA*	NA
Foskett Speckled Dace	Threatened	LAA	NA	NA
Lower Columbia River Chinook Salmon	Threatened	LAA	LAA	MAA
Upper Columbia River Spring-Run Chinook	Endangered	LAA	LAA	MAA
Puget Sound Chinook Salmon	Threatened	LAA	LAA	MAA
Snake River Fall-Run Chinook Salmon	Threatened	LAA	LAA	MAA
Snake River Spring/Summer Run Chinook	Threatened	LAA	LAA	MAA
Upper Willamette River Chinook	Threatened	LAA	LAA	MAA
Lower Columbia River Chum Salmon	Threatened	LAA	LAA	NA
Hood Canal Summer Run Chum Salmon	Threatened	LAA	LAA	NA
Lower Columbia Coho Salmon	Threatened	LAA	LAA**	MAA
Southern Oregon/Northern California Coho	Threatened	LAA	LAA	MAA
Oregon Coast Coho Salmon	Threatened	LAA	LAA	MAA
Ozette Lake Sockeye Salmon	Threatened	LAA	LAA	NA
Snake River Sockeye Salmon	Endangered	LAA	LAA	NA
Lower Columbia River Steelhead	Threatened	LAA	LAA	NA
Middle Columbia River Steelhead	Threatened	LAA	LAA	NA
Upper Columbia River Steelhead	Endangered	LAA	LAA	NA
Snake River Basin Steelhead	Threatened	LAA	LAA	NA
Upper Willamette River Steelhead	Threatened	LAA	LAA	NA
Puget Sound Steelhead	Threatened	LAA	LAA**	NA
All non-listed MSA Chinook, coho, and pink salmon	NA	NA	NA	MAA

*The FWS will assess CH for Warner Sucker and Borax Chub in the subsequent Biological Opinion (Paul Bridges, USFWS Roseburg Office, pers. comm. January 16, 2013)

**The proposed rule for designation of CH for Lower Columbia River Coho Salmon and Puget Sound Steelhead was issued on January 14, 2013 (50 CFR Part 226, Vol. 78, No. 9, pp. 2726-2796). ARBA II effects to proposed CH was assessed in Table 42.

5. **Effects on Terrestrial Species –** For the listed wildlife species analyzed in this ARBA II, aquatic restoration actions “may affect, likely to adversely affect” (LAA) only two bird species (MAMU and NSO) typically associated with noise disturbance during critical breeding times. The majority of programmatic aquatic restoration actions that take place in or near listed bird habitats can occur outside of critical nesting periods so as to avoid a LAA determination. No habitat for listed birds will be removed under this consultation. For all other listed terrestrial plant and wildlife species, aquatic restoration activities conducted under this consultation will result in a “may affect, not likely to adversely affect” determination.

   a. **Birds**

      i. **Marbled Murrelet/Designated Critical Habitat –** Potential effects of the aquatic restoration projects on the marbled murrelet are associated with disturbance associated with activities that would occur during the critical nesting period from April 1 through August 6 (restricted to no more than 1 activities that disrupt MAMU per administrative unit [Ranger District, Resource Area] per year on average) with 2 hour dawn and dusk daily timing restrictions during the entire breeding season (April 1 to Sept 15). To help reduce adverse effects to marbled murrelets, whenever feasible, projects will be scheduled outside of the murrelet breeding season. If it is not possible to avoid projects during the breeding season, every effort will be made to schedule projects during the late breeding season (August 7 – September 15).

      Harassment could occur with the following: 1) noise interrupts and/or precludes essential nesting and feeding behaviors; 2) noise/visual stimuli is in such close proximity to the nest that the activity is perceived as a threat and causes flushing from the nest or missed feedings; or 3) noise is loud and sudden which causes flushing from a nest. Effects of harassment on murrelets could result in reduced reproduction or mortality of young due to avoidance of an area for nesting, adults flushing from the nest, increased susceptibility to predation, aborted feeding of young, nest abandonment, and premature fledging.

      Adverse effects on marbled murrelet suitable or potential habitat or designated critical habitat are not expected to occur because nest trees and PCE 1 will be avoided and limited impacts to PCE 2 will not modify the function of the PCE 2 stands. If suitable or potential MAMU habitat must be removed, the project falls outside the scope of this ARBA II and consultation must be initiated separately to address those effects.

      ii. **Northern Spotted Owl –** Potential effects of the aquatic restoration projects on the NSO are associated with disturbance from activities that would occur during the critical nesting season (restricted to no more than 1 activity that disturb NSO per Administrative Unit [Ranger District or Resource Area] per year). The critical period generally occurs from March 1 through July 15 although this period may change slightly on individual Units. Although many of the projects will be scheduled outside of this period due to work windows that minimize impacts on fish, it is expected that some projects will occur during the nesting period that may adversely affect owls.

Harassment for owls is similar to that for marbled murrelets, and could occur with the following: 1) noise interrupts and/or precludes essential nesting and feeding behaviors; 2) noise/visual stimuli is in such close proximity to the nest that the activity is perceived as a threat and causes flushing from the nest or missed feedings; or 3) noise is loud and sudden which causes flushing from a nest. Effects of harassment on spotted owls could result in reduced reproduction or mortality of young due to avoidance of an area for nesting, adults flushing from the nest, increased susceptibility to predation, aborted feeding of young, nest abandonment, and premature fledging.

Adverse effects on spotted owl suitable habitat, 2008 designated critical habitat, or proposed critical habitat are not expected to occur because most construction activities will occur in the road prism and in poor quality riparian habitat (e.g., pre-commercial thinning in plantations). If occupied or un-surveyed suitable or potential habitat must be removed, the project falls outside the scope of this ARBA II and consultation must be initiated separately to address those effects.

Criteria NS01 and NS02 may be waived in a particular year if nesting or reproductive success surveys conducted according to spotted owl survey guidelines reveal that spotted owls are non-nesting or that no young are present that year. Waivers are valid only until March 1 of the following year. Previously known sites/activity centers are assumed occupied unless protocol surveys indicate otherwise.

b. Mammals

i. **Canada Lynx –** The primary potential effects on lynx from the programmatic actions are associated with disturbance. Most construction activities will occur in the road prism or poor quality riparian habitats where vegetation has been previous degraded or removed. Information in the Lynx Conservation and Assessment Strategy (Ruediger et al. 2000) was used to evaluate potential effects on lynx.

To date, most investigations of lynx have not shown human presence to influence how lynx use the landscape (Aubry et al. 2000). There have been no studies designed to determine the effects of human disturbance on lynx. Studies that have been conducted have reported anecdotal observations regarding lynx apparent tolerance of human presence. Several studies of lynx in the taiga have been conducted in areas of relatively dense rural human populations and agricultural development, suggesting that lynx can tolerate moderate levels of human disturbance. An exception to this may be activities around a den site that may cause abandonment of the site, possibly affecting kitten survival (Ruggerio et al. 2000). Current research indicates lynx may tolerate limited disturbance, even around active dens, but the level of tolerance is unknown.

Projects “may affect, but are not likely to adversely affect” lynx due to PDCs that ensure disturbance is avoided, via establishment of distance buffers around known lynx dens.

ii. **Gray Wolf –** Gray wolves are currently rare or non-existent throughout most of the area where the aquatic restoration projects will be implemented, and it is unlikely locations will directly impact any animals or active den sites. Projects will be of relatively short duration and should not affect prey availability or disturb wolves if animals are present in the area. Therefore, the determination of "may affect, but not likely to adversely affect" is appropriate for this species if the following is considered.

    The action meets Recovery Plan direction for den and rendezvous sites (i.e., no projects/activities within 1 mile of den or rendezvous sites scheduled to occur between April 15 and June 30).

iii. **Grizzly Bear** – Potential effects of the projects on grizzly bears include habitat loss and disturbance. However, the amount of habitat removal or degradation near aquatic restoration activities is expected to be minimal (less than 1 acre of low quality riparian habitat for any project). Work will not occur in areas that may affect bears during sensitive time periods when animals could be present. Therefore, with implementation of grizzly bear PDCs to avoid or minimize effects, the activities "may affect, but are not likely to adversely affect" the grizzly bear.

iv. **Woodland Caribou –** Potential effects of the proposed action on woodland caribou include habitat loss and disturbance. However, the amount of habitat removal or degradation near project sites in the caribou recovery area in the Selkirk Mountains is expected to be minimal and will not displace caribou or result in short-term degradation of riparian areas in caribou habitat. Direct mortality or sub-lethal effects are unlikely. Work will not occur in sensitive areas identified by the local wildlife biologist. Implementation of the projects as described in this ARBA II "may affect, but are not likely to adversely affect" the woodland caribou.

c. Plants – For the listed plants analyzed in this BA, direct effects would occur from physical disturbance to individual plants and populations that immediately affected plant growth, survival, and or reproduction. Indirect effects would occur from project-related changes in habitat that affect the plants through time, and other changes that can influence growth and reproduction (e.g., increases or decreases in competition from other plants, the introduction of noxious weeds, increasing light to the plants from thinning, etc.).

Field surveys for listed plants and suitable habitat will occur prior to federal activities during the growing season, before aquatic restoration activities would occur. Any listed plant or plant suitable habitat discovered during the survey that is within 0.25 miles of the proposed aquatic restoration project will cause project planners to design the restoration activity to be "not likely to adversely affect" listed plants. Understanding plant distribution and avoiding the plants during restoration activities has proven to be the best way to facilitate conservation for these species and to meet the goals of the agencies. In some cases restoration activities are consistent with listed plant recovery actions and can benefit listed species.

6. Cumulative Effects

a. **Scope** – In the context of the Endangered Species Act (ESA), cumulative effects encompass the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the covered area (in this case the entirety of the States of Oregon and Washington). Future Federal actions, including those that are unrelated to the proposed action, are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

   Cumulative effects, in the context of Section 7 consultation, are generic to the area of consideration and not related to the Federal action. The cumulative effects analysis is therefore independent of the specific restoration activities addressed in this programmatic ARBA II and addresses impacts in the context of general trends in population and land-use.

b. **Population Trends –** Oregon's estimated 2009 population was 3,823,460. Oregon's population increased by 2.5 times since 1950, and is expected to reach 4.4 million by the year 2020 (State of Oregon Department of Administrative Services 2010). Over a thirty year forecast period (from 2010 to 2040), Washington State's population is expected to grow by just over 2.0 million, reaching 8,791,000 (State of Washington Office of Financial Management 2011).

c. **Residential, Commercial, and Infrastructure Development –** Intuitively, population growth results in increasing residential and commercial development. Improvements and upgrades to infrastructure (including highways, other transportation facilities, pipelines, power lines, and power plants) will likely track closely with increased residential and commercial development. Primary pathways of potential effects of land development include the following: direct habitat loss, decreased water quality, contamination of waterways and uplands, changes to runoff patterns, habitat fragmentation, isolation of populations, and loss of habitat diversity. In general, as development increases the quantity and quality of habitat suitable for threatened and endangered species typically decreases. Based on past trends and types of development, future residential, commercial, and infrastructure development will likely lead to further habitat degradation. Actions taken to mitigate for the potential impacts of development may help slow the rate of habitat degradation.

d. **Agriculture** – Assuming future trends mirror the historical pattern in Oregon and Washington, substantial additional impacts to fish and wildlife due to agriculture are not expected. However, in many areas within the programmatic area, certain ongoing agricultural practices (such as irrigation, chemical application, and regular habitat disturbance in agricultural areas) are likely to prevent habitat from reaching properly functioning conditions for listed species.

e. **Forestry** – In Oregon and Washington, non-federal timber harvest typically involves clear-cutting. Impacts due to clear-cutting and forest roads have been well documented and such impacts are long lasting and additive. Timber harvest and associated impacts are concentrated in western Oregon and Washington; however, timber harvest is anticipated to occur, to varying degrees, throughout the programmatic area. Although the rate of harvest appears to be slowing in some areas and improved forestry practices have been implemented, the collective impacts of past and reasonably foreseeable future forestry activities are likely to result in additional future degradation of habitat for listed species.

f. **Pollutant Discharge** – Air and water pollution can degrade habitat and have lethal and sub-lethal effects on fish and wildlife. Increased human population typically causes increased air and water pollution. Developed areas also generate effluent, and runoff is often polluted with a variety of substances. In Oregon, each of the sub-basins within the programmatic area contain 303(d)- listed streams with water temperature being the most frequent parameter exceeding state standards. Other notable parameters include bacteria, dissolved oxygen, flow modification, habitat modification, nutrients, pH, sedimentation, total dissolved gas, toxics and turbidity. In a like manner, nearly 60 percent of the lakes, streams, and estuaries for which there is data fail to meet water quality standards in Washington as of 1999 (WDNR 2000)

   Ongoing activities in Oregon and Washington will help mitigate and/or reverse pollutant sinks and sources. The Oregon Department of Environmental Quality (DEQ), for instance, has completed 30 TMDLs for major basins across the state (http://www.deq.state.or.us/wq/tmdls/tmdls.htm). Even still, pollutant discharges will likely continue in the future and are very likely to degrade habitat for listed species.

g. **Oregon and Washington Fish Recovery Efforts**

   i. **Oregon –** Beginning in 1997**,** the State of Oregon developed a comprehensive aquatic conservation strategy (The Oregon Plan). The goal of the Oregon Plan is to "restore populations and fisheries to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits." Components of this plan include the following: 1) coordination of efforts by local, state, and federal governments as well as tribal, private, and other interests; 2) development of action plans with relevance and ownership at the local level; 3) monitoring progress; and (4) making appropriate corrective changes in the future. This process included chartering 84 locally formed "watershed councils" across the State. Membership on the watershed councils includes landowners, businesses interests, agricultural interests, sport fishers, irrigation/water districts, individuals, State, Federal, and Tribal agencies, and local government officials.

      Further, since 1990, the State of Oregon has taken several actions to address the conservation and recovery of bull trout. More restrictive harvest regulations were implemented beginning in 1990; by 1994 the harvest of bull trout was prohibited throughout the State with the sole exception of Lake Billy Chinook in central Oregon. Bull trout working groups have been established in the Klamath, Deschutes, Hood, Willamette, Odell Lake, Umatilla and Walla Walla, John Day, Malheur, and Pine Creek river basins for the purpose of developing bull trout conservation strategies. In addition, the Oregon Department of Fish and Wildlife reduced the stocking of hatchery-reared rainbow trout and brook trout in areas where bull trout occur, and genetic analysis for most bull trout populations was completed in 1997.

      From 1997-2009, Oregon Plan efforts have led to the following watershed outcomes:

      - Riparian Miles Treated – 5,463
      - Road Miles closed or decommissioned – 2,572
      - Road Miles Improved – 9,064
      - Irrigation Diversions/Screens Installed – 864

- Stream Crossings Improved/Miles Fish Access Restored – 2,764/4,150
- Push-up dams Retired –135

Results can be found at **www.oregon.gov/OWEB/biennialreport2011.shtml**

ii. **Washington –** Washington State has developed a salmon restoration strategy to help recover dwindling fish stocks. A draft Statewide Strategy to Recover Salmon, "Extinction is not an Option," was produced by the Washington Governor's Salmon Recovery Office (Washington Governor's Salmon Recovery Office 1999) and Joint Natural Resources Cabinet. The plan describes how State agencies and local governments will work together to address habitat, harvest, hatcheries, and hydropower as they relate to recovery of listed species. While the Washington Governor's plan focuses primarily on salmon, many of the same factors affecting salmon also impact bull trout.

The Washington State legislature created the Salmon Recovery Act (ESHB 2496) and Watershed Management Act (ESHB 2514) to assist in salmon recovery efforts. The Watershed Management Act provided funding and a planning framework for locally based watershed management groups to address water quality and quantity. The Salmon Recovery Act provides direction for the development of limiting factors analyses on salmon habitat and creates a list of prioritized restoration projects. While not specifically targeting limiting factors for bull trout, these documents have played an important role in the development of bull trout recovery unit chapters.

To further enhance bull trout populations, the Washington Department of Fish and Wildlife no longer stocks brook trout in streams or lakes connected to bull trout waters. Fishing regulations prohibit harvest of bull trout, except for a few areas where stocks are considered "healthy". The Washington Department of Fish and Wildlife is also currently involved in a mapping effort to update bull trout distribution data within the State of Washington, including all known occurrences, spawning and rearing areas, and potential habitats. Likewise, the salmon and steelhead inventory and assessment program is currently updating their database to include the entire State, which consists of an inventory of stream reaches and associated habitat parameters important for the recovery of salmonid species and bull trout.

7. Conclusion for cumulative effects – The ESA listings of fish and wildlife species in the States of Oregon and Washington have been based, in part, on the additive impacts of growth, development, and other human activities. At this point, the trends discussed above indicate that future impacts will progress similarly, leading to additional adverse impacts on all fish and wildlife and their habitats. Changes to past development practices and fish recovery efforts in Oregon and Washington provide hope that past trends are not predictive of future circumstances.

VI. References (Aquatics)

Allen, C., A. Atkins, and M. Stern. 1994. Status and Recolonization of the Warner sucker (*Catostomus warnerensis*) and other fishes in the Warner Lakes in Southeast Oregon, 1994. Unpublished report to Bureau of Land Management and Oregon Department of Fish and Wildlife. 22 pp.

Anderson, J.W., Beschta, R.L., Boehne, P.L., Bryson, D., Gill, R., McIntosh, B.A., Purser, M.D., Rhodes, J.J., Sedell, J.W., and Zakel, J. 1993. A comprehensive approach to restoring habitat conditions needed to protect threatened salmon species in a severely degraded river -- The Upper Grande Ronde River Anadromous Fish Habitat Protection, Restoration and Monitoring Plan. Riparian Management: Common Threads and Shared Interests, pp. 175-179, USFS Gen. Tech. Rept. RM-226, Fort Collins, Co.

Andreasen, J.K. 1975. Systematics and Status of the Family Catostomidae in southern Oregon. Ph.D. Thesis, Oregon State University, Corvallis, Oregon. 80 p.

Armour, C.L. 1990. Guidance for evaluating and recommending temperature regimes to protect fish. U.S. Fish and Wildlife Service. Fort Collins. Biological Report 90(22). 13 p.

Baker, M.B. 1990. Hydrologic and Water Quality Effects of Fire. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-191, pp. 31-42.

Barnard, B. 2011. Deer Lagoon Alternatives Analysis. Washington Department of Fish and Wildlife. http://wildfishconservancy.org/projects/deer-lagoon-restoration-assessment/DeerLagoonalternativeanalysis_website.pdf.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America.

Baxter, J.S., E.B. Taylor, R.H. Devlin, J. Hagen and J.D. McPhail. 1997. Evidence for natural hybridization between Dolly Varden (*Salvelinus malma*) and bull trout (*S. confluentus*) in a northcentral British Columbia watershed. Canadian Journal of Fisheries and Aquatic Sciences 54:421-429.

Baxter, C.V. 2002. Fish Movement and Assemblage Dynamics in a Pacific Northwest Riverscape. Ph.D. Dissertation, Oregon State University, Corvallis, OR. 174 pp.

Beak Consultants Inc. 1987. Shortnose and Lost River sucker studies: Copco reservoir and the Klamath River. Report prepared for the City of Klamath Falls, Oregon. June 30, 1987. 55 p.

Beauchamp, D.A. and J.J. VanTassell. 2001. Modeling seasonal trophic interactions of adfluvial bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society 130:204-16.

Bedell, T. E., L.E. Eddleman, T. Deboodt, C. Jakes. 1993. Western Juniper- Its Impact and Management in Oregon Rangelands. Oregon State University Extension Service. EC 1417. February 1993.

Beechie, T.J., D.A. Sear, J.D. Olden, G.R. Pess, J.M. Buffington, H. Moir,, P. Roni, and M.M. Pollock. 2010. Process-based Principles for Restoring River Ecosystems. Bioscience 60:209-222.

Behnke, R.J. 1979. Monograph of the native trouts of the genus Salmo of eastern North America. Unpub. Man. 215pp.

Behnke, R. J. & D. E. Benson, 1980. Endangered and threatened fishes of the upper Colorado River Basin. Colorado State University Cooperative Extension Service Bulletin 503A, Fort Collins, Colorado, USA

Behnke, R. J. 1981. Systematic and zoogeographical interpretation of Great Basin trouts. In R. J. Naiman, and D. L. Soltz (editors), Fishes in the North American deserts, p. 95-124. Wiley, New York.

Behnke, R. J. & D. E. Benson, 1980. Endangered and threatened fishes of the upper Colorado River Basin. Colorado State University Cooperative Extension Service Bulletin 503A, Fort Collins, Colorado, USA

Bencala, K.E., Kennedy, V.C., Zellweger, G.W., Jackman and A.P, Avanzino, R.J. 1984. Interactions of solutes and streambed sediment 1. An experimental analysis of cation and anion transport in a mountain stream. Water Resources Research. 20:1797–1803

Benda, L. and W. Zhang. 1990. The hydrological and geomorphological characteristics of landslide/dam break floods in the Cascade Range of Washington. EOS, Transactions of the American Geophysical Union.

Benda, L., Beechie, T.J., Wissmar, R.C., and A. Johnson. 1992. Morphology and evolution of salmonid habitats in a recently deglaciated river basin, Washington State, USA. Can, J. Fish. Aqua. Sc. 49:1246-1256.

Berg, L. and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Onchorhynchus kisutch*) following a short-term pulses of suspended sediment. Can. J. Fish. Aqua. Sc. 42:1410-1417.

Bestcha, R.L. and W.S. Platts. 1986. Morphological features of small streams: significance and function. Water Resources Bulletin 22(3):369-379

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 *in* E.D. Salo and T.W. Cundy (eds). Streamside Management Forestry and Fisheries Interactions. Institute of Forest Resources, University of Washington, Seattle, Washington, Contribution No. 57.

Beschta, R. L., W. S. Platts, and J. B. Kauffman. 1991. Field review of fish habitat improvement projects in the Grande Ronde and John Day River basins of eastern Oregon. DOE/BP-21493-1. U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Bills, F.T. 1977. Taxonomic status of isolated populations of tui chub referred to *Gila bicolor oregonensis* (Snyder). Master's thesis. Oregon State University, Corvallis, Oregon 116 pp.

Bindoff, N.L., J. Willebrand, V. Artale, A. Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quéré, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley, and A. Unnikrishnan. 2007. Observations: Oceanic climate change and sea level. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller, (editors). Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom and New York. http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch5.html.

Biological Review Team (BRT). 2003. Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead. 142 pages. February. NOAA Fisheries, 525 NE Oregon Street, Suite 500, Portland, Oregon 97232-2737. (Available @ www.nwfsc.noaa.gov/)

Bisson, P.A., R.E. Bilby, M.D. Bryant, C.A. Dolloff, G.B, Grette, R.A. House, M.L. Murphy, K.V. Koski, and J.R. Sedell. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. *In*. Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Seattle, Washington: University of Washington, Institute of Forest Resources:143-190.

Bisson, P.A., T.P. Quinn, G.H. Reeves, and S.V. Gregory. 1992. Best management practices, cumulative effects, and long-term trends in fish abundance in Pacific Northwest river systems. In: Naiman, R.J. ed. Watershed management: balancing sustainability and environmental change. New York, NY: Springer-Verlag. 189-232.

Bjornn, T. C., D. R. Craddock, and D. R. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon, Oncorhynchus nerka. Trans. Am. Fish. Soc. 97(4):360-373

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Publication 19. 83-138.

Boag, T.D. 1987. Food habits of bull char (*Salvelinus confluentus*), and rainbow trout (*Salmo gairdneri*), coexisting in a foothills stream in northern Alberta. Canadian Field-Naturalist 101(1):56-62.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 *In*: Howell, P.J. and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Bottom, D. L., K. K. Jones, and M. J. Herring. 1984. Fishes of the Columbia River estuary. Columbia River Estuary Data Development Program. 113 p.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: The role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-68. 246 p.

Bradbury, B., W. Nehlsen, T.E. Nickelson, K.M.S. Moore, R.M. Hughes, D. Heller, J. Nicholas, D.L. Bottom, W.E. Weaver, and R.L. Beschta. 1995. Handbook for prioritizing watershed protection and restoration to aid recovery of native salmon: Ad hoc working group sponsored by Oregon State Senator Bill Bradbury, Pacific Rivers Council. 56 p.

Brenkman, S.J. and S.C. Corbett. 2005. Extent of Anadromy in Bull Trout and Implications for Conservation of a Threatened Species. North American Journal of Fisheries Management. 25:1073–1081.

Brewin, P.A., M.K. Brewin, and M. Monita. 1997. Distribution maps for bull trout in Alberta. Pages 206-216 *in* W.C. Mackay, M.K. Brewin, and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Bridges, P. 2013. Pers. comm. USFWS Roseburg Office, January 16, 2013.

Brown, L.G. 1994. The zoogeography and life history of Washington native charr. Report # 94-04. Washington Department of Fish and Wildlife, Fisheries Management Division, Olympia, WA, November, 1992, 47 pp.

BRT (Biological Review Team). 1997. Status review update for West Coast steelhead from Washington, Idaho, Oregon, and California. National Marine Fisheries Service, West Coast Steelhead BRT, Portland, Oregon.

BRT (Biological Review Team). 2003. Endangered and Threatened Species: Status Review Updates for Snake River Sockeye Salmon and Southern California Steelhead; and Additional Information Request for Nine Evolutionarily Significant Units of West Coast Steelhead. National Marine Fisheries Service, West Coast Steelhead BRT, Portland, Oregon.

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout, distribution, life history, limiting factors, management considerations, and status. Report to Bonneville Power Administration. Contract No. 1994BI34342, Project No. 199505400 (BPA Report DOE/BP-34342-5). Oregon Department of Fish and Wildlife, Portland, OR. 185pp.

Buchanan, D.M., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 1-8 *in* W.C. Mackay, M.K. Brewin and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force(Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Buckman, R.C., W.E. Hosford and P.A. Dupee. 1992. Malheur river bull trout investigations. Pages 45-57 *in* Howell, P.J. and D.V. Buchanan, eds., Proceedings of the Gearhart Mountain bull trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Burgner, R.L., J.T. Light, Margolis, T.L. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific. International North Pacific Fisheries Commission Bulletin 51:1-92.

Burkey, T.V. 1989. Extinction in nature reserves: the effect of fragmentation and the importance of migration between reserve fragments. Oikos 55:75-81.

Burkey, T.V. 1995. Extinction rates in archipelagoes: Implications for populations in fragmented habitats. Conservation Biology 9: 527-541.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-27.

Busch, S., P. McElhany, and M. Ruckelshaus. 2008. A comparison of the viability criteria developed for management of ESA listed Pacific salmon and steelhead. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle. http://www.nwfsc.noaa.gov/trt/trt_documents/viability_criteria_comparison_essay_oct_10.pdf.

Cairns, M.A., J.L. Ebersole, J.P. Parker, P.J. Wigington Jr., H.R. Lavigne, and S.M. Davis. 2005. Influence of Summer Stream Temperatures on Black Spot Infestation of Juvenile Coho Salmon in the Oregon Coast Range. Transactions of the American Fisheries Society 134 (6):1471-1479.

Castro. J. 2003. Geomorphic impacts of culvert replacement and removal:avoiding channel incision. US Fish and Wildlife Service. Portland, Or.

Cavender, T. M. 1978. Taxonomy and distribution of the bull trout *(Salvelinus confluentus)* (Suckley), from the American northwest. Calif. Fish and Game 64:139-174.

Cederholm, C.J. and N.P. Peterson. 1985. The retention of Coho salmon (*Onchorhynchus kisutch*) carcasses in spawning streams. Canadian Journal of Fisheries and Aquatic Sciences 42:1222-1225.

Chamberlin, T.W., Harr, R.D., and E.F. Everest. 1991. Timber Harvesting, Silviculture, and Watershed Processes. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, Am. Fish. Soc. Special Publ. 19: 181-205.

Chapman, D.W. and K.L. Witty. 1993. Habitats of weak salmon stocks of the Snake River basin and feasible recovery measures Recovery issues for threatened and endangered Snake River Salmon, Technical report 1 of 11. Report to Bonneville Power Administration. Contract Number DE-AM79-93BP99654. Portland, Oregon.

Compton, J.E, C.P. Andersen, D.L. Phillips, J. R. Brooks, M.G. Johnson, M.R. Church, W.E. Hogsett, M.A. Cairns, P.T. Rygiewicz, B.C. McComb, and C.D. Shaff. 2006. Ecological and water quality consequences of nutrient addition for salmon restoration in the Pacific Northwest. Frontier in Ecology, 4(1): 18–26

Connor, E., D. Reiser, K. Binkley, D. Paige, and K. Lynch. 1997. Abundance and distribution of an unexploited bull trout population in the Cedar River Watershed, Washington. Pages 403-411 *in* Mackay, W.C., M.K. Brewin, and M. Monita, editors. Friends of the bull trout conference proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Canada, Calgary.

Cooper, J.J. 1983. Distributional ecology of native and introduced fishes of the Pit River system, northeastern California, with notes on the Modoc sucker. California Fish and Game 69:39-53.

Cooney, T. D. 2000. UCR steelhead and spring Chinook salmon quantitative analysis report. Part 1: run reconstructions and preliminary assessment of extinction risk. Technical Review Draft. National Marine Fisheries Service, Hydro Program, Portland, Oregon.

Cordone, A.J. and D.W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game 47:189-228.

Costello, A.B., T.E. Down, S.M. Pollard, C.J. Pacas, and E.B. Taylor. 2003. The influence of history and contemporary stream hydrology on the evolution of genetic diversity within species: an examination of microsatellite DNA variation in bull trout, *Salvelinus confluentus* (Pisces: Salmonidae). Evolution. 57(2):328-344.

Craig, S.D., and R.C. Wissmar. 1993. Habitat conditions influencing a remnant bull trout spawning population, Gold Creek, Washington (draft report). Fisheries Research Institute, University of Washington. Seattle, Washington.

Crispin, V., R. House, and D. Roberts. 1993. Changes in instream habitat large woody debris and salmon habitat after restructuring of a coastal Oregon stream. North American Journal of Fisheries Management 13:96-102.

Crone, R. A., and C. E. Bond. 1976. Life history of coho salmon, *Oncorhynchus kisutch*, in Sashin Creek, southeastern Alaska. Fish. Bull. 74(4):897–923.

Currens, K.P., R.R. Fuerstenberg, W.H. Graeber, K. Rawson, M.H. Ruckelshaus, N.J. Sands, and J.B. Scott. 2009. Identification of an independent population of sockeye salmon in Lake Ozette, Washington. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-96, 18 p.

Dambacher, J. M., A. G. Talabere, D. L. Hill, and D. F. Markle. 1997. Foskett speckled dace investigations. Fish Research Progress Report. Oregon Department of Fish and Wildlife and Oregon State University.

Davis, B. and R. Miller. 1967. Brain patterns in minnows of the genus *Hybopsis* in relation to feeding habits and habitat. Copeia 1967:1-39.

Donald, D.B. and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71:238-247.

Drake, J., R. Emmett, K. Fresh, R. Gustafson, M. Rowse, D. Teel, M. Wilson, P. Adams, E.A.K. Spangler, and R. Spangler. 2008. Summary of scientific conclusions of the review of the status of eulachon (*Thaleichthys pacificus*) in Washington, Oregon and California. Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle.

Dunham, J., G.L. Vinyard, and B.E. Rieman. 1997. Habitat Fragmentation and Extinction Risk of Lahontan Cutthroat Trout. North American Journal of Fisheries Management 17:1126-1133.

Dunham, J. B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications, 9(2), 1999, pp 642-655.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: influences of physical, biotic and geometrical landscape characteristics. Ecological Applications 9:642-655.

Dunham, J., B. Rieman & G. Chandler. 2003. Influences of Temperature and Environmental Variables on the Distribution of Bull Trout within Streams at the Southern Margin of Its Range. *North American Journal of Fisheries Management* 2003;23:894–904

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman and Co., San Francisco, CA: 818 pp.

Edwards, RT. 1998. The hyporheic zone. 399–429 in Naiman RJ, Bilby RE, eds River Ecology and Management: Lessons From the Pacific Coastal Ecoregion. New York: Springer-Verlag

Elmore, W. and R.L. Bestcha. 1987. Riparian areas: perceptions in management. Rangelands 9(6):260-265.

Everest, F.H.; Bestcha, R.L.; Scrivener, J.C.; Kiski, K.V.; Sedell, J.R.; Cederholm, C.J. 1987. Fine sediment and salmonid production: a paradox. In. Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution 57. Seattle, Washington: University of Washington, Institute of Forest Resources. 98-142. (FEMAT)

Fausch, K.D. and T.G. Northcote. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Canadian Journal of Fisheries and Aquatic Sciences 49:682-693.

Feist, B.E., J.J. Anderson, and R. Miyamoto. 1996. Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution. Fisheries Research Institute Report No. FRI-UW-9603. School of Fisheries, University of Washington. Seattle.

Fernald, A.G., P.J. Wigington, and D.H. Landers. 2001. Transient storage and hyporheic flow along the Willamette River, Oregon: Field measurements and model estimates. Water Resources Research 37(6):1681-1694. http://www.agu.org/pubs/crossref/2001/2000WR900338.shtml.

Fishbase 2011. http://www.fishbase.org/summary/SpeciesSummary.php?genusname = Salvelinus&speciesname=confluentus

Fisher, T. and R. Hinrichsen. 2004. Preliminary abundance-based trend results for Columbia basin salmon and steelhead ESUs. Report for J. Geiselman, Bonneville Power Administration, Portland, OR.

Foerster, R. E. 1968. The sockeye salmon. Bulletin of the Fisheries Research Board of Canada. No. 162. 422 p.

Ford, M.J., (editor). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-113. 281 p.

FEMAT (Forest Ecosystem Management Assessment Team). 1993. Forest ecosystem management: an ecological, economic, and social assessment. Portland, OR: U.S. Department of Agriculture; U.S Department of Interior [and others]. [irregular pagination].

Foerster, R. E. 1968. The sockeye salmon, Oncorhynchus nerka. Bull. Fish. Res. Board Can. 162, 422 p.

Fowler W.B., Anderson T.D., Helvey J.D. 1988. Changes in Water Quality and Climate after Forest Hazards in Central Washington. USDA Forest Service Research Paper. PNW-RP-388 Portland

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout *(Salvelinus confluentus)* in the Flathead Lake and River system, Montana. Northwest Science 63:133-143.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. U.S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station, USDA Forest Service General Technical Report PNW-8, Portland, Oregon.

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River Basin salmon and steelhead: An evaluation of the effects of selected factors on salmonid population viability. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-69. 105 p.

Frissell, C.A. 1993 . A new strategy for watershed restoration and recovery of Pacific salmon in the Pacific Northwest. The Pacific Rivers Council, Eugene, Oregon

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Open File Report Number 156-99. Flathead Lake Biological Station, University of Montana, Polson, MT, 46 pp.

Fulton, L. A. 1968. Spawning areas and abundance of Chinook salmon, *Oncorhynchus tshawytsc*ha, in the Columbia River basin – past and present. U.S. Fish and Wildlife Service, Special Scientific Report, Fisheries 571:26.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. Pages 297-324 in W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. Amer. Fish. Soc. , Spec, Pub. 19, Bethesda, Maryland.

Garling, D. L. and M. Masterson. 1985. Survival of Lake Michigan Chinook salmon eggs and fry incubated at three temperatures. Prog. Fish-Culturist 47:63-66.

Gende SM, Edwards RT, Willson MF, and Wipfli MS. 2002. Pacific salmon in aquatic and terrestrial ecosystems. BioScience.

Geppert, R.R., Lorenz, C.W., and Larson, A.G. 1984. Cumulative Effects of Forest Practices on the Environment: A State of the Knowledge. Wash. For. Practices Board Proj. No. 0130, Dept. of Natural Resources, Olympia, Wash.

Gerking, S.D. 1994. Feeding ecology of fish. Academic Press, San Diego, California. 51 pp.
Hoelscher, B. and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Project F-710R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, Idaho.

Gerstung, E.R. 1986. The status and management of the Lahontan cutthroat trout (*Salmo clarki hemshawi*). Pages 81-101 in J.S. Griffith (ed.). The ecology and mangement of the interior stocks of cutthroat trout. West. Div. Am. Fish. Soc. Spec. Publ.

Gilbert, C.H. 1898. The fishes of the Klamath Basin. Bull. U.S. Fish Comm. 17(1897): 1-13. Hewitt, D.A., B.S. Hayes, E.C. Janney, A.C. Harris, J.P. Koller, and M.A. Johnson. 2011. Demographics and Run Time of Adult Lost River (*Deltistes luxatus*) and Shortnose (*Chasmistes brevirostris*) Suckers in Upper Klamath Lake, Oregon 2009. USGS Open File Report 2011-1088.

Gilbert, C. H. 1912. Age at maturity of Pacific coast salmon of the genus *Oncorhynchus*. Bull. U.S. Fish Comm. 32:57–70.

Godfrey, H., K. A. Henry, and S. Machidori. 1975. Distribution and abundance of coho salmon in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 31.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, literature review. U.S. Forest Service, Willamette National Forest, Eugene, Oregon.

Goetz, F. 1994. Distribution and juvenile ecology of bull trout (*Salvelinus confluentus*) in the Cascade Mountains. Master's Thesis. Oregon State University, Corvallis, OR.

Goetz, F., E. Jeanes, and E. Beamer. 2004. Bull trout in the nearshore. Preliminary draft. U.S. Army Corps of Engineers, Seattle, Washington, June, 2004, 396 pp.

Good, T.P., R.S. Waples, and P. Adams, (editors). 2005. Updated status of federally listed ESUs of west coast salmon and steelhead. West Coast Salmon Biological Review Team. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-NWFSC-66. 598 p.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41:540-551.

Gregory, S., L. Ashkenas, D. Oetter, P. Minear, and K. Wildman. 2002a. Historical Willamette River channel change. Pages 18-26 *in* D. Hulse, S. Gregory, and J. Baker, (editors). Willamette River Basin planning atlas: Trajectories of environmental and ecological change. Oregon State University Press. Corvallis, Oregon. http://www.fsl.orst.edu/pnwerc/wrb/Atlas_web_compressed/3.Water_Resources/3c.historic_chl_web.pdf.

Gregory, S., L. Ashkenas, D. Oetter, P. Minear, R. Wildman, P. Minear, S. Jett, and K. Wildman. 2002b. Revetments. Pages 32-33 *in* D. Hulse, S. Gregory, and J. Baker, (editors). Willamette River Basin planning atlas: Trajectories of environmental and ecological change. Oregon State University Press. Corvallis, Oregon. http://www.fsl.orst.edu/pnwerc/wrb/Atlas_web_compressed/3.Water_Resources/3g.revetments_web.pdf.

Gregory, S., L. Ashkenas, P. Haggerty, D. Oetter, K. Wildman, D. Hulse, A. Branscomb, and J. Van Sickle. 2002c. Riparian vegetation. Pages 40-43 *in* D. Hulse, S. Gregory, and J. Baker, (editors). Willamette River Basin planning atlas: Trajectories of environmental and ecological change. Oregon State University Press. Corvallis, Oregon. http://www.fsl.orst.edu/pnwerc/wrb/Atlas_web_compressed/4.Biotic_Systems/4c.riparian_veg_web.pdf.

Gresswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Trans. Amer. Fish. Soc. 128, 193-221.

Gustafson, R.G., T.C. Wainwright, G.A. Winans, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-33, 282 pp.

Gustafson, R., J. Drake, R. Emmett, K. Fresh, M. Rowse, D. Teel, M. Wilson, P. Adams, E. Spangler, R. Spangler. 2008. Summary of Scientific Conclusions of the Review of the Status of Eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. Biological Review Team, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington. December 18.

Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-105. 360 p.

Gustafson, R.G., M.J. Ford, P.B. Adams, J.S. Drake, R.L. Emmett, K.L. Fresh, M. Rowse, E.A.K. Spangler, R.E. Spangler, D.J. Teel, and M.T. Wilson. 2011. Conservation status of eulachon in the California Current. Fish and Fisheries. doi:10.1111/j.1467-2979.2011.00418.x.

Haas, G.R., and J.D. McPhail. 1991. Systematics and distributions of Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. Canadian Journal of Fisheries and Aquatic Sciences 48:2191-2211.

Haas, G.R., and J.D. McPhail. 2001. The post-Wisconsin glacial biogeography of bull trout (Salvelinus confluentus): a multivariate morphometric approach for conservation biology and management. Canadian Journal of Fisheries and Aquatic Sciences 58:2189-2203.

Haggerty, M.J., A.C. Ritchie, J.G. Shellberg, M.J. Crewson, and J. Jalonen. 2009. Lake Ozette sockeye limiting factors analysis. Prepared for the Makah Indian Tribe and NOAA Fisheries in cooperation with the Lake Ozette Sockeye Steering Committee. Port Angeles, Washington. http://www.mhaggertyconsulting.com/Lake_Ozette_Sockeye.php.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17: 304-326.

Hard, J.J., J.M. Myers, M.J. Ford, R.G. Cope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams, P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound steel head (*Oncorhynchus mykiss*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-81, 117 p.

Hari, R. E., D. M. Livingstone, R. Siber, P. Burkhardt-Holm, and H. Guttinger. 2006. Consequences of climatic change for water temperature and brown trout populations in alpine rivers and streams. Global Change Biology 12:10–26.

Harr, R.D., W.C. Harper, J.T. Krygier, and F.S. Hsieh. 1975. Changes in storm hydrographs after road building and clear cutting in the Oregon Coast Range. Water Resources Research 11(3):436-444.

Hartman, G.F., J.C. Scrivener, and M.J. Miles. 1996. Impacts of logging in Carnation Creek, a high-energy coastal stream in British Columbia, and their implication for restoring fish habitat. Canadian Journal of Fisheries and Aquatic Sciences 53(Suppl. 1):237-251.

Healey, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-84.

Hebdon, J.L., P. Kline, D. Taki, and T.A. Flagg. 2004. Evaluating reintroduction strategies for Redfish Lake Sockeye Salmon captive brood progeny. American Fisheries Society Symposium 44:401-413. http://www.mendeley.com/research/evaluating-reintroduction-strategies-redfish-lake-sockeye-salmon-captive-broodstock-progeny/.

Heede, B.H. 1985. Channel adjustments to the removal of log steps: an experiment in a mountain stream. Environ. Manage. 9:427-432.

Henjum, M.G., J.R. Karr, D.L. Bottom, D.A. Perry, J.C. Bednarz, S.G. Wright, S.A. Beckwitt, and E. Beckwitt. 1994. Interim protection for late-successional forests, fisheries, and watersheds. National forests east of the Cascade Crest, Oregon, and Washington. A report to the Congress and President of the United States Eastside Forests Scientific Society Panel. American Fisheries Society, American Ornithologists Union Incorporated, The Ecological Society of America, Society for Conservation Biology, The Wildlife Society. The Wildlife Society Technical Review 94-2.

Heusser, C. J. 1949. History of an estuarine bog at Secaucus, New Jersey. Bulletin of the Torrey Botanical Club. 76:385–406

Hewitt, D.A., Hayes, B.S., Janney, E.C., Harris, A.C., Koller, J.P., and M.A. Johnson. 2011. Demographics and run timing of adult Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers in Upper Klamath Lake, Oregon, 2009: U.S. Geological Survey

Hicks, D. 2005. Lower Rogue watershed assessment. South Coast Watershed Council, Gold Beach, Oregon. August.

Hicks, B.J., Bestcha, R.L., Bisson, P.A.; Sedell, J.R. 1991. Response of salmonids to habitat change. Amer. Fish. Soc. Spec. Pub. 19: 483-518.

Hoelscher, B., and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Project F-710R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, Idaho.

Hood Canal Coordinating Council. 2005. Hood Canal & Eastern Strait of Juan de Fuca summer chum salmon recovery plan. November 15.

Howe, C.B. 1968. Ancient Tribes of the Klamath Country. Bindfords and Mort, Portland, Oregon. 252 p.

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Knedra, and D. Orrmann. 1985. Stock Assessment of Columbia River Anadromous Salmonids (Project 83-335, 2 volumes), Final Report to Bonneville Power Administration, Portland, Oregon.

Howell, P.J., and D.V. Buchanan. 1992. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: A review of the biological effects, mechanical causes, and options for mitigation. Washington Department of Fisheries. Technical Report No. 119. Olympia, Washington.

IC-TRT. 2003. Working draft. Independent populations of Chinook, steelhead, and sockeye for listed evolutionarily significant units within the Interior Columbia River domain. July. U.S. Department of Commerce, NOAA Fisheries.

IC-TRT. 2007. Viability criteria for application to Interior Columbia Basin salmonid ESUs. Interior Columbia Tecnical Recovery Team, review draft (March). Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle.

IC-TRT. 2011. Draft recovery plan for Idaho Snake River spring/summer Chinook and steelhead populations in the Snake River spring/summer Chinook salmon evolutionarily significant unit and Snake River steelhead distinct population segment (chapters 1-3). National Marine Fisheries Service, Northwest Region, Protected Resources Division. Boise, Idaho. http://www.idahosalmonrecovery.net.

Interagency Restoration Database (IRDA). 2003. Watershed Restoration Tracking and Reporting System. USDA Forest Service and USDI Bureau of Land Management, Core Regional Data System Requirements/Documentation, Version 2.0.2. Updated December 18, 2003.

Interior Columbia Basin Technical Recovery Team (ICTRT). 2003. http://www.nwfsc.noaa.gov/trt/trt_columbia.cfm

Idaho Department of Environmental Quality. 2011. Idaho Department of Environmental Quality final 2010 integrated report. Boise, Idaho.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: the physical science basis. Available: www.ipcc.ch. (February 2007).

Irving, J. S., and T. C. Bjornn. 1981. Status of Snake River fall Chinook salmon in relation to the Endangered Species Act. Idaho Cooperative Fishery Research Unit, University of Idaho, Moscow, for U.S. Fish and Wildlife Service.

ISAB, (editor). 2007. Climate change impacts on Columbia River Basin fish and wildlife. Climate Change Report, ISAB 2007-2. Independent Scientific Advisory Board, Northwest Power and Conservation Council. Portland, Oregon.

Johnston, N.T., S.A. Bird, D.L. Hogan, and E.A. Wallace. 2011. Mechanisms and source distances for the input of large woody debris to forested streams in British Columbia, Canada. Canadian J. For. Res. 41:2231-2246.

Joint Columbia River Management Staff. 2009. 2010 joint staff report concerning stock status and fisheries for sturgeon and smelt. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. http://wdfw.wa.gov/publications/00886/wdfw00886.pdf.

Jones, J.A. and G.E. Grant. 1996. Cumulative effects of forest harvest on peak stormflow in the western cascades of Oregon. Water Resources Research 32(4):959-974.

Keefer, M.L., C.A. Peery, and M.J. Henrich. 2008. Temperature mediated en route migration mortality and travel rates of endangered Snake River sockeye salmon. Ecology of Freshwater Fish 17:136-145.

Keim, R.F., Skaugset, A.E. 2002 . Physical Aquatic Habitat II. Pools and Cover Affected by Large Woody Debris in Three Western Oregon Streams. North American Journal of Fisheries Management 22:151–164.

Keller, E.A., A. MacDonald, T. Tally, and N.J. Merrit. 1985. Effects of large organic debris on channel morphology and sediment storage in selected tributaries of Redwood Creek, northwestern California. Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California. K.M. Nolan, H.M. Kelsey and D.C. Maron. Vicksburg, MS, US Geological Survey:29.

Kelsey, H.M., Madej, M.A., Pitlick, J., Coughlan, M., Best, D., Bending, R. and P. Stroud. 1981. Sediment sources and sediment transport in the Redwood Creek Basin: a progress report. Redwood National Park Research and Development Technical Report 3. National Park Service. 114 p.

King, J.G. and Tennyson, L.C. 1984. Alteration of streamflow following road construction in north central Idaho. Water Resour. Res., 20: 1159-1163.

Kohler, A.E., T.D. Pearsons, J.S. Zendt, M.G. Mesa, C.L. Johnson, and P.J. Connolly. 2012. Nutrient Enrichment with Salmon Carcass Analogs in the Columbia River Basin, USA: A Stream Food Web Analysis. Transactions of the American Fisheries Society 141 (3):802-824.

Kondolf, G.M. 1997. Hungry water: Effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

Kostow, K, editor. 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife, Portland.

Larson, R. and B.J. Brush. 2010. Upper Klamath Basin Wetlands: An Assessment. Unpublished report. U.S. Fish and Wildlife Service. Klamath Falls, Oregon. 25 p.

Latterell, J.J. and R.J. Naiman. 2007. Sources and dynamics of large logs in a temperature floodplain river. Ecological Applications, 17(4):1127-1141.

Laufle, J. C., G. B. Pauley, and M. F. Shepard. 1986. Species profiles. Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest): Coho salmon. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.48)

Lawson, P.W., E.P. Bjorkstedt, M.W. Chilcote, C.W. Huntington, J.S. Mills, K.M. Moores, T.E. Nickelson, G.H. Reeves, H.A. Stout, T.C. Wainwright, and L.A. Weitkamp. 2007. Identification of historical populations of coho salmon (*Onchorynchus kisutch*) in the Oregon Coast evolutionarily significant unit. NMFS-NWFSC-79 U.S. Department of Commerce, NOAA Technical Memorandum. 129 p.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology [CONSERV. BIOL.] **7** 856-865.

Leary, R.F., and F.W. Allendorf. 1997. Genetic confirmation of sympatric Bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720.

Leathe, S.A., and P. Graham. 1982. Flathead Lake fish food habits study. Environmental Protection Agency, through Steering Committee for the Flathead River Basin Environmental Impact Study. Contract R008224-01-4 to Montana Department of Fish, Wildlife, and Parks.

Lee, D.S., C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr. 1980. Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History. Raleigh, North Carolina. 867 pp

Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, J.E. Williams and others. 1997. Chapter 4: Broadscale Assessment of Aquatic Species and Habitats. *In* T.M. Quigley and S. J. Arbelbide eds "An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins Volume III". U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management, Gen Tech Rep PNW-GTR-405).

Leopold, L. 1994. A View of a River. Cambridge, MA: Harvard University Press.

Light, J., L. Herger, and M. Robinson. 1996. Upper Klamath basin bull trout conservation strategy, a conceptual framework for recovery. Part one. The Klamath Basin Bull Trout Working Group.

Lisle, T.E. 1989. Sediment transport and resulting deposition in spawning gravels, North Coastal California. Water Resources Research 25(6):1303-1319.

Lohr, S., S. Duke, T. Cummings, and W. Fredenberg. 2001. Listing of Bull Trout as Threatened Species in the United States and Initial Steps in Recovery Planning. In Berwin, M.K., A.J. Paul, and M. Monita. 2001. Bull Trout II Conference Proceedings. 199-205.

Lotspeich, F.B. and F.H. Everest. 1981. A new method for reporting and interpreting textural composition of spawning gravel. Pacific Northwest Forest and Range Experiment Station, Research Note PNW-369.USDA Forest Service. Corvallis, OR.

Loudenslager, E.J. and G.A.E. Gall. 1980. Geographic patterns of protein variation and subspeciation in cutthroat trout, Salmo clarki.. Syst. Zool. 29:27-42

Lower Columbia River Estuary Partnership. 2007. Lower Columbia River and estuary ecosystem monitoring: Water quality and salmon sampling report. Portland, Oregon.

Lower Columbia Fish Recovery Board. 2010. Washington lower Columbia salmon recovery & fish and wildlife subbasin plan. Olympia, Washington. May 28. http://www.lcfrb.gen.wa.us/Recovery%20Plans/RP%20Frontpage.htm.

Loyd, D.S., Koenings, J.P. and J.D. LaPerriere. 1987. Effects of turbidity in fresh waters of Alaska. N. Amer. J. Fish. Manage. 7:18-33.

MacDonald, L.H., Smart, A.W., and Wissmar, R.C. 1991. Monitoring Guidelines to Evaluate Effects of Forestry on Streams in the Pacific Northwest and Alaska. EPA 910/9-91-001, USEPA, Water Division, Region 10, Seattle, Wash.

Maguire, M. 2001. Chetco River watershed assessment. South Coast Watershed Council, Gold Beach, Oregon.

Makah Fisheries Management. 2000. Lake Ozette sockeye hatchery and genetic management plan - Biological assessment, section 7 consultation. October 23, 2000. Prepared by Makah Fisheries Management for Bureau of Indian Affairs. Makah Indian Tribe. Neah Bay, Washington. 219p.

Markle, D., T. Pearsons and D. Bills. 1991. Natural history of *Oregonichthys* (Pisces: Cyprinidae), with a description of a new species from the Umpqua River of Oregon. Copeia 1991 (2): 277-293.

Martin, M. 1967. The distribution and morphology of the North American catostomid fishes of the Pit River system, California. M.A. thesis, Sacramento State Univ., Sacramento, California. 67 pp.

Martin, M. 1972. Morphology and variation of the Modoc sucker, *Catostomus microps* Rutter, with notes on feeding adaptations. Calif. Dept. Fish and Game 58(4):277-284.

Matthews, G.M. and R.S. Waples. 1991. Status Review for Snake River Spring and Summer Chinook Salmon. U.S. Department of Commerce, NOAA Technical Memo.NMFSF/NWC-200.

MBTSG (Montana Bull Trout Scientific Group). 1995a. Upper Clark Fork River drainage bull trout status report (including Rock Creek). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995b. Bitterroot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995c. Blackfoot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995d. Flathead River drainage bull trout status report (including Flathead Lake, the North and Middle forks of the Flathead River and the Stillwater and Whitefish River). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995e. South Fork Flathead River drainage bull trout status report (upstream of Hungry Horse Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996a. Swan River drainage bull trout status report (including Swan Lake). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996b. Lower Clark Fork River drainage bull trout status report (Cabinet Gorge Dam to Thompson Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996c. Middle Clark Fork River drainage bull trout status report (from Thompson Falls to Milltown, including the lower Flathead River to Kerr Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996d. Lower Kootenai River drainage bull trout status report (below Kootenai Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996e. Middle Kootenai River drainage bull trout status report (between Kootenai Falls and Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996f. Upper Kootenai River drainage bull trout status report (including Lake Koocanusa, upstream of Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

McClure, B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000. Revised Appendix B of standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. September.

McCullough, D.A. 1999. A Review and Synthesis of Effects of Alterations to the Water Temperature Regime on Freshwater Life Stages of Salmonids, with Special Reference to Chinook Salmon. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington. EPA 910-R-99-010.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-42. Seattle. 156 p.

McElhany, P., C. Busack, M. Chilcote, S. Kolmes, B. McIntosh, J. Myers, D. Rawding, A. Steel, C. Steward, D. Ward, T. Whitesel, and C. Willis. 2006. Revised viability criteria for salmon and steelhead in the Willamette and Lower Columbia basins. Review Draft. Willamette/Lower Columbia Technical Recovery Team and Oregon Department of Fish and Wildlife.

McElhany, P., M. Chilcote, J. Myers, and R. Beamesderfer. 2007. Viability status of Oregon salmon and steelhead populations in the Willamette and Lower Columbia Basins. Prepared for Oregon Department of Fish and Wildlife and National Marine Fisheries Service, Portland, Oregon.

McIntosh, B.A. 1992. Historical Changes in Anadromous Fish Habitat in the Upper Grande Ronde River, Oregon, 1941-1990. Unpub. M.S. thesis, Ore. State Univ., Corvallis, Or.

McIntosh, B.A., Sedell, J.R., Smith, J.E., Wissmar, R.C., Clarke, S.E., Reeves, G.H., and Brown, L.A. 1994. Management History of Eastside Ecosystems: Changes in Fish Habitat Over 50 years, 1935 to 1992. Eastside Forest Ecosystem Health Assessment, Vol III, USFS Gen. Tech. Rept. PNWGTR- 321, Portland, Or.

McPhail, J.D. and J.S. Baxter. 1996. A review of bull trout (Salvelinus confluentus) life-history and habitat use in relation to compensation and improvement opportunities. Fisheries management report no. 104. University of British Columbia. Vancouver, B.C.

McPhail, J.D. and C. Murray. 1979. The early life history of Dolly Varden *(Salvelinus malma)* in the upper Arrow Lakes. Report to the British Columbia Hydro and Power Authority and Kootenay Department of Fish and Wildlife. University of British Columbia, Department of Zoology and Institute of Animal Resources, Vancouver, B.C. (As referenced in USDI, 1997 and EPA Temp).

Meehan, W.R. 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19.

Meffe, G.K., and C.R. Carroll. 1994. Principles of conservation biology. Sinauer Associates, Inc. Sunderland, Massachusetts.

Megahan, W.F. 1982. Channel sediment storage behind obstructions in forested drainage basins draining the granitic bedrock of the Idaho batholith. In: Swanson, [and others]. Sediment budgets and routing in forested drainage basins. General Technical Report PNW-141. Portland, Oregon: USDA Forest Service, Pac. NW. Res. St. 114-121.

Mersereau, R.C., and C.T. Dyrness. 1972. Accelerated Mass Wasting after Logging and Slash Burning in Western Oregon. *Journal of Soil and Water Conservation*, 27:112-114.Mersereau, R.C., and C.T. Dyrness. 1972. Accelerated Mass Wasting after Logging and Slash Burning in Western Oregon. Journal of Soil and Water Conservation, 27:112-114.

Miller, R.F., J.D. Bates, T.J. Svejcar, F.B. Pierson, and L.E. Eddleman. 2005. Biology, ecology, and management of western juniper (Juniper occidentalis). Tech. Bull. 152. Oregon State University Agr. Exper. Station.

Miller, R. and G. Smith. 1981. Distribution and evolution of *Chasmistes* (Pisces:Catostomidae) in western North America. Occasional papers of the Museum Zoology, University of Michigan. Number 696. Ann Arbor, Michigan.

Miller, R., Tausch, R., and W. Waichler. 1999. Old-Growth Juniper and Pinyon Woodlands. Pages 375-384 in: Monsen, S., S. Richards, R. Tausch, R. Miller, C. Goodrich; Proceedings-Ecology and Management of Pinyon-Juniper Communities within the Interior West. USDA-FS RMRS-P9.

Miller, M. 2000. Fire Autecology. In: Brown, J.K., Smith, J.K. (Eds.), Wildland fire and ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-412-vol 2, USDA Forest Service, Ogden, UT, pp. 9-34.

Mills, T.J. 1980. Life history, status, and management of the Modoc sucker, *Cutostomus microps* (Rutter) in California, with a recommendation for endangered classification. California Department of Fish and Game, Inland Fish, Endangered Species Program. Spec. Publ. 80-6.

Minshall, G.W., Brock, J.T., Varley, J.D. 1989. Wildfires and Yellowstone's stream ecosystems. BioScience 39, 707-715.

Minshall, G.W., Robinson, C.T., Royer, T. V., Rushforth, S. R. 1995. Benthic community structure in two adjacent streams in Yellowstone National Park five years after the 1988 wildfires. Great Basin Naturalist 55, 193-200.

Montgomery, D.R., J.M. Buffington, R.D. Smith, K.M. Schmidt, and G. Pess. 1995. Pool spacing in forest channels. Water Resources Research 31:9.

Moyle, P.B. 1976. Inland fishes of California. University of California Press, Berkeley. 405 pp.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berkeley, California. Pages 195-204.

Moyle, P.B. and R.A. Daniels. 1982. Fishes of the Pit River system, McCloud River system, and Surprise Valley region. Univ. Calif. Publ. Zool. 115:1-82.

Moyle, P.B. and A. Marciochi. 1975. Biology of the Modoc sucker, *Catostomus microps*, in northeastern California. Copeia 1975(3):556-560.

Moyle, P.B and G.M. Sato. 1991. On the design of preserves to protect native fishes. In: Minckley, W.L.; Deacon, J.E., eds. Battle against extinction: native fish management in the American west. Tucson, Arizona: University of Arizona Press. 155-169.

Murphy, M.L., and J.D. Hall. 1981. Varied effects of clear-cut logging on predators and their habitat in small streams of the Cascade Mountains, Oregon. Canadian Journal of Fisheries and Aquatic Sciences 38:137-145.

Murphy, M.L and W.R. Meehan. 1991. Stream ecosystems. American Fisheries Society Special Publication 19. 179-246 p.

Murray, C.B. and J.D. McPhail. 1988. Effect of incubation temperature on the development of five species of Pacific salmon (Onchorhynchus) embryos and alevins. Can. J. Zool. 66(1):266-273.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-35.

Myers, J.M., C. Busack, D. Rawding, A. R. Marshall, D. J. Teel, D. M. Van Doornik, and M.T. Maher. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-73. 311 p. http://www.nwfsc.noaa.gov/assets/25/6490_04042006_153011_PopIdTM73Final.pdf.

Myrick, C.A., F.T. Barrow, J.B. Dunham, B.L. Gamett, G. Haas, J.T. Peterson, B. Rieman, L.A. Weber, and A.V. Zale. 2002. Bull trout temperature thresholds. Peer review summary prepared for U.S. Fish and Wildlife Service

Naiman, R.J., Beechie, TJ., Benda, L.E., Berg, D.R., Bisson, P.A., MacDonald, P.A., O'Connor, M.D., Olson, P.L., and E.A. Steel. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion. In: Naiman, R.J., ed. Watershed management: balancing sustainability and environmental change. New York, NY: Springer-Verlag. 127-188 p.

Naiman, R.J., Bilby, R.E., Bisson, P.A. 2000. Riparian Ecology and Management in the Pacific Coastal Rain Forest. BioScience, Vol. 50, Issue 11. pp. 996-1011.

National Fire Plan. 2002. http://www.fireplan.gov/

Nehlsen, W., J. Williams, and J. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(02):4-21.

Newton, J.A., and S. Pribyl. 1994. Bull trout population summary: Lower Deschutes River subbasin. Oregon Department of Fish and Wildlife, The Dalles, Oregon. Oregon administrative rules, proposed amendments to OAR 340-41-685 and OAR 340-41-026. January 11, 1996.

NMFS (National Marine Fisheries Service). 1995 (as amended). Juvenile Fish Screen Criteria for Pump Intakes. National Marine Fisheries Service, Environmental and Technical Services Division. Portland, OR.

NMFS (National Marine Fisheries Service). 1996. Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale. National Marine Fisheries Service, Environmental and Technical Services Division, Habitat Conservation Branch.

NMFS (National Marine Fisheries Service). 1999. Biological opinion on artificial propagation in the Columbia River basin – incidental take of listed salmon and steelhead from Federal and non- Federal hatchery programs that collect, rear, and release unlisted fish species. NMFS, Sustainable Fisheries Division, Portland, Oregon. (March 29, 1999)

NMFS (National Marine Fisheries Service). 2000. Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. Washington, Oregon, Idaho, and California. http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf

NMFS (National Marine Fisheries Service). 2005. Status Review Updates for Snake River Sockeye Salmon and Southern California Steelhead; and Additional Information Request for Nine Evolutionarily Significant Units of West Coast Steelhead. Portland, OR.

NMFS (National Marine Fisheries Service). 2005a. Updates to the May 18, 2004, Salmonid Hatchery Inventory and Effects Evaluation report. Salmon Recovery Division.

NMFS (National Marine Fisheries Service). 2007a. 2007 Report to Congress: Pacific Coastal Salmon Recovery Fund, FY 2000-2006. U.S. Department of Commerce, NOAA, National Marine Fisheries Service. Washington, D.C.

NMFS (National Marine Fisheries Service). 2007b. Recovery plan for the Hood Canal and eastern Strait of Juan de Fuca summer chum salmon (*Oncorhynchus keta*). National Marine Fisheries Service, Northwest Region. Portland, Oregon.

NMFS (National Marine Fisheries Service). 2007c. Draft. Dawgz 'n the hood: The Hood Canal summer chum salmon ESU. Puget Sound Technical Recovery Team, Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle. February 28.

NMFS (National Marine Fisheries Service). 2009a. Recovery plan for Lake Ozette sockeye salmon (*Oncorhynchus nerka*). National Marine Fisheries Service, Salmon Recovery Division. Portland, Oregon. 394 pp.

NMFS(National Marine Fisheries Service). 2009b. Middle Columbia River steelhead distinct population segment ESA recovery plan. November 30. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Mid-Columbia/Mid-Col-Plan.cfm.

NMFS (National Marine Fisheries Service). 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2011a. 5-year review: summary and evaluation of Lower Columbia River Chinook, Columbia River chum, Lower Columbia River coho, and Lower Columbia River steelhead. National Marine Fisheries Service. Portland, Oregon.

NMFS (National Marine Fisheries Service). 2011b. 5-year review: summary and evaluation of Snake River sockeye, Snake River spring-summer Chinook, Snake River fall-run Chinook, Snake River Basin steelhead. National Marine Fisheries Service, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2011c. Columbia River estuary ESA recovery plan module for salmon and steelhead. Prepared for NMFS by the Lower Columbia River Estuary Partnership (contractor) and PC Trask & Associates, Inc. (subcontractor). National Marine Fisheries Service, Northwest Region. Portland, Oregon. January. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/upload/Estuary-Mod.pdf.

NMFS (National Marine Fisheries Service). 2012a. Proposed ESA recovery plan for Lower Columbia River coho salmon, Lower Columbia River Chinook salmon, Columbia River chum salmon, and Lower Columbia River steelhead. National Marine Fisheries Service, Northwest Region. April. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Willamette-Lower-Columbia/LC/upload/LC-plan.pdf.

NMFS (National Marine Fisheries Service). 2012b. Public draft recovery plan for southern Oregon/northern California coast coho salmon (*Oncorhynchus kisutch*). National Marine Fisheries Service. Arcata, California.

NOAA (National Oceanic and Atmospheric Administration). 1993. Designated Critical Habitat; Snake River Sockeye Salmon, Snake River Spring/Summer Chinook Salmon and Snake River Fall Chinook Salmon. Final Rule. Federal Register, December 28, 1993: 68543-68554.

NOAA (National Oceanic and Atmospheric Administration). 1998. Section 7 Consultation on the Effects of Continued Implementation of Land and Resource Management Plans on Endangered Species Act Listed Salmon and Steelhead in the Upper Columbia and Snake River Basins. NOAA Fisheries, Northwest Region, Seattle, Washington. Biological Opinion. June. 121 p. (Available @ www.nwr.noaa.gov under Habitat Conservation Division, Biological Opinions).

NOAA (National Oceanic and Atmospheric Administration). 1999. Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids. National Marine Fisheries Service Northwest Region Habitat Conservation and Protected Resources Divisions. 26 August 1999. Portland OR.

NOAA (National Oceanic and Atmospheric Administration). 2003. Updated status of Federally listed ESUs of West Coast salmon and steelhead. West Coast Salmon Biological Review Team. NOAA Fisheries Northwest and Southwest Fisheries Science Centers. July 31, 2003.

NOAA Fisheries. 2005a. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Oceanic and Atmospheric Administration, NMFS-Protected Resources Division. Portland, Oregon.

NOAA (National Oceanic and Atmospheric Administration). 2005b. Endangered and Threatened Species; Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon and Idaho; Final Rule. Federal Register, Friday, September 2, 2005: 52630-52838.

NOAA Fisheries. 2011. Biennial report to Congress on the recovery program for threatened and endangered species October 1, 2008 – September 30, 2010. NOAA-National Marine Fisheries Service. Washington, D.C.

Natural Resources Conservation Service (NRCS). 2001. Livestock Water Access and Ford Stream Crossings. Engineering Technical Note Number MT-13. Bozeman, Montana.

Neville-Arsenault, H. 2003. Genetic assessment of complex dynamics in an interior salmonid metapopulation. PhD Dissertation, University of Nevada, Reno.

Nicholas, J., B. McIntosh, E. Bowles, Oregon Watershed Enhancement Board, and Oregon Department of Fish and Wildlife. 2005. Coho assessment, Part 1: Synthesis Final Report. Salem, Oregon. May 6.

Nickelson, T. E., J. D. Rodgers, S. L. Johnson, and M. F. Solazzi. 1992a. Seasonal changes in habitat use by juvenile coho (*Oncorhynchus kisutch*) in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 49:783-789.

Nickelson, T. E., M. F. Solazzi, S. L. Johnson, and J. D. Rodgers. 1992b. Effectiveness of selected stream improvement techniques to create suitable summer and winter rearing habitat for juvenile coho (*Oncorhynchus kisutch*) in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 49:790-794.

Noggle, C.C. 1978. Behavioral, physiological and lethal effects of suspended sediments to juvenile salmonids. Master's thesis. University of Washington, Seattle.

Noss, R.F., M.A. O'Connel, and D.D. Murphy. 1997. The Science of Conservation Planning: Habitat Conservation Under the Endangered Species Act. Island Press, Washington D.C., and Covelo, California. 246 pp.

ODEQ (Oregon Department of Environmental Quality). 1995. 1992-1994 Water quality standards review: Dissolved oxygen - Final issue paper. Oregon Department of Environmental Quality, Portland, OR.

ODFW (Oregon Department of Fish and Wildlife). 1998. Memorandum re: harvest rates for Willamette spring Chinook, to J. Martin from S. Sharr, ODFW, Portland. (September 30).

ODFW (Oregon Department of Fish and Wildlife). 2004. Annual Progress Report, Fish Research Project Oregon. Project Number: F-163-R-09. Salem OR.

ODFW (Oregon Department of Fish and Wildlife). 2005. Oregon Plan for Salmon and Watersheds Oregon Coast Coho Assessment Habitat. https://nrimp.dfw.state.or.us/crl/Reports/AI/Oregon%20Coast%20Coho%20ESU%20Habitat%20Assessment.pdf

ODFW (Oregon Department of Fish and Wildlife). 2010. Lower Columbia River conservation and recovery plan for Oregon populations of salmon and steelheadOregon Department of Fish and Wildlife. Salem, Oregon.

ODFW and NMFS (Oregon Department of Fish and Wildlife and National Marine Fisheries Service. 2011. Upper Willamette River conservation and recovery plan for Chinook salmon and steelhead. Oregon Department of Fish and Wildlife and National Marine Fisheries Service, Northwest Region. August 5.

Office of Financial Management (OFM), Forecasting Division. Washington State 2002 Population Trends. Olympia, Washington, September 2002

Oregon Department of Administrative Services (ODAS). 1999. Oregon economic and revenue forecast. Vol. XIX. No. 2. Office of Economic Analysis, Salem.

Pearlstine L. G., V. M. Kitchens, P. F. Latham, R. D. Bartleson. 1993. Tide gate influence on a tidal marsh. Water Resources Bulletin. 29:1009–1019.

Pearsons, T. 1989. Ecology and decline ofa rare western minnow: the Oregon chub (*Oregonichhys crameri*). M.S. thesis. Oregon State University, Corvallis, Oregon. 86 pp.

Peets, Scott. 2012. Pers. comm. Fisheries Biologist, USDA Forest Service, Corvallis, OR.

Platts, W. S. 1989. Compatibility of livestock grazing with fisheries. Pages 103-110 in R. E. Gresswell, B. A. Barton, and J. L. Kershner, eds. Practical Approaches to Riparian Resource Management. Montana Bur. Land Manage. Rep. BLM-MT-PT-89-001-4351.

Pollock, M., J. Wheaton, N. Bouwes, C. Jordan and N. Weber. 2012. Using beaver to reconnect floolplains and restore riparian habitat in an incised stream. AWRA 2012 Summer Specialty Conference. Riparian Ecosystems IV: Advancing Science, Economic Policy. Denver, Colorado.

Porter, M. and M. Nelitz. 2009. A future outlook on the effects of climate change on bull trout (*Salvelinus confluentus*) habitats in the Cariboo-Chilcotin. Prepared by ESSA Technologies Ltd.for Fraser Salmon and Watersheds Program, B.C. Ministry of Environment, and Pacific Fisheries Resource Conservation Council.

Portnoy, J. W. 1996. Effects of diking, drainage, and seawater restoration on salt marsh biogeochemical cycling. Bulletin of the Ecological Society of America Supplement. Part 2, Supplement to annual meeting of 1996.

Portnoy, J. W. 1999. Salt marsh diking and restoration: biogeochemical implications of altered wetland hydrology. Environmental Management. 24:111–120.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game in cooperation with the Pend Oreille Idaho Club

Pratt, K.L. 1992. A review of Bull trout life history. Pages *5-9 in* P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (*Salvelinus confluentus*) in Lake Pend Oreille and the lower Clark Fork River. Draft report. Prepared for the Washington Water Power Company, Spokane, Washington.

Pritchard, A. L. 1940. Studies on the age of the coho salmon (*Oncorhynchus kisutch*) and the spring salmon (*Oncorhynchus tshawytscha*) in British Columbia. Trans. R. Soc. Can., Serv. 3, 34(V):99–120.

Quigley, T.M. and S.J. Arbelbide, tech. editors. 1997. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins: volume III. General Technical Report PNW- GTR-405. U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management

Raposa, K.B., C.T. Roman. 2001. Seasonal habitat use patterns of nekton in a tide restricted and unrestricted New England salt marsh. Wetlands. 21:451–461

Ratliff, D.E. 1992. Bull trout investigation in the Metolius River-Lake Billy Chinook system. Pages 37-44. *In* Howell, P.J. and D.V. Buchanan, eds., Proceedings of the Gearhart Mountain bull trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 *in*: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis.

Ray, C. 2001. Maintaining genetic diversity despite local extinctions: effects of population scale. Biological Conservation, 100 (1):3-14.

Ray, C. M. M. Peacock and J. B. Dunham. 2000. Population structure and persistence of Lahontan cutthroat trout: results from a comparative study of isolated and networked streams. Interim report for cooperative agreement FWS 14-48-0001-95646.

Reed, D.H., J.J. O'Grady, J.D. Ballou, and R. Frankham. 2003. The frequency and severity of catastrophic die-offs in vertebrates. Animal Conservation 6:109-114.

Reeves, G. H., Fred H. Everest, Thomas E. Nickelson. 1989. Identification of physical habitats limiting the production of coho salmon in western Oregon and Washington. Gen. Tech. Rep. PNW-GTR-245. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.

Reeves, G.H., J.D. Hall, T.D. Roelofs, T.L. Hickman, and C.O. Baker. 1991. Rehabilitating and modifying stream habitats. American Fisheries Society Special Publications 19. 519-557.

Reeves, G.H., L.E. Benda, K.M. Burnett, P.A. Bisson, and J.R. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionary significant units of anadromous salmonids in the Pacific Northwest. American Fisheries Society Symposium 17:334-349.

Reeves, G.H., J.D. Sleeper, and D.W. Long. 2001. Seasonal changes in habitat availability and the distribution and abundance of salmonids along a stream gradient from headwaters to mouth in coastal Oregon. Transactions of the American Fisheries Society 140 (3): 537-548.

Reid, S.B. 2007. Surveys for the Modoc sucker, *Catostomus microps*, in the Goose Lake Basin, Oregon - 2007. Final Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office, Cooperative Agreement No. 81450-6-J533.

Reid, S.B. 2008. Conservation Review - Modoc sucker, *Catostomus microps*. Final Report submitted to U.S. Fish and Wildlife Service – Klamath Falls Field Office. Version date: 31 December 2008.

Reiser, D. W., and T. C. Bjornn. 1979. Habitat requirements of anadromous salmonids. Chapter 1. *in* W. R. Meehan [tech. ed.] Influence of forest and rangeland management on anadromous fish habitat in the western United States and Canada.

Reimers, P.E., and R.E. Loeffel. 1967. The length of residence of juvenile fall Chinook salmon in selected Columbia River tributaries. Fish Commission of Oregon 13:5-19.

Rich, C.F., Jr. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. M.S. Thesis, Montana State University, Bozeman, Montana.

Richards, C., and G. W. Minshall. 1992. Spatial and temporal trends in stream macroinvertebrate communities: The influence of catchment disturbance. Hydrobiologia 241:173–184

Richter, D.D., C.W. Ralston, and W.R. Harms. 1982. Prescribed Fire: Effects on Water Quality and Forest Nutrient Cycling (Hydraulic Systems, Pine Litter, USA). Science, 215:661-663.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin 191, Ottawa, Ontario.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. US Forest Service, Intermountain Research Station. General Technical Report INT-302.

Rieman, B.E. and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society. Vol. 124 (3): 285-296.

Rieman, B.E., and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132-141.

Rieman, B., and J. Clayton. 1997. Wildfire and native fish: Issues of forest health and conservation of sensitive species. Fisheries 22:6-14.

Rieman, B.E., D.C. Lee and R.F. Thurow. 1997. Distribution, status and likely future trends of bull trout within the Columbia River and Klamath Basins. North American Journal of Fisheries Management 17(4): 1111-1125.

Rieman, B.E., and J.B. Dunham. 2000. Metapopulations and salmonids: a synthesis of life history patterns and empirical observations. Ecology of Freshwater Fish 9:51-64.

Rieman, B.E., and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764. American Fisheries Society, Bethesda, Maryland.

Rieman, B.E., J.T. Peterson and D.L. Myers. 2006. Have brook trout (*Salvelinus fontinalis*) displaced bull trout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fisheries and Aquatic Sciences. Vol. 63, No. 1, pp. 63–78(16)

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, D. Myers. 2007. Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin. Transactions of the American Fisheries Society. 136:1552-1565.

Robichaud, P.R., J.W. Wagenbrenner, and R.E. Brown. 2010. Rill erosion in natural and undisturbed forests: 1. Measurements. Water Resources Research 46 (W10506).

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.H. Lachner, R.N. Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication 12, Bethesda, Maryland.

Rode, M. 1990. Bull trout, *(Salvelinus confluentus)* Suckley, in the McCloud River: status and recovery recommendations. Administrative Report Number 90-15. California Department of Fish and Game, Sacramento, CA.

Rogue Basin Coordinating Council. 2006. Watershed health factors assessment: Rogue River Basin. Rogue Basin Coordinating Council, Talent, Oregon. March 31.

Roman, C.T., W.A. Niering, R. S. Warren. 1984. Salt marsh vegetation change in response to tidal restriction. Environmental Management. 8:141–150

Roman, C.T., R.W. Garvine, J.W. Portnoy. 1995. Hydrologic modeling as a predictive basis for ecological restoration of salt marshes. Environmental Management. 19:559–566.

Roni, P., T.J. Beechie, R.E. Bilby, F.E. Leonetti, M.M. Pollock, and G.R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in pacific northwest streams. North American Journal of Fisheries Management 22:1-20.

Rosgen, D.L. 1994. A classification of natural rivers. Catena 22:169-199. http://www.wildlandhydrology.com/assets/a_classification_of_natural_rivers-catena_paper.pdf.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO.

Rozsa, R. 1997. Human impacts on tidal wetlands: history and regulations. Accessed @ http://camel2.conncoll.edu/ccrec/greenet/ arbo/publications/.

Sandercock, F. K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). *In* C. Groot and L. Margolis (eds.), Pacific salmon life histories, p. 396–445. University of British Columbia Press,Vancouver, BC.

Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: A review. Conservation Biology 5:18-32.

Scheerer, P. 1997. Oregon chub research. Middle fork Willamette and Santiam River drainages. Annual Progress Report. E96960048. 40 pp.

Scheerer, P.D. and P.J. McDonald. 2000. Oregon chub research: Middle Fork Willamette and Santiam River Drainages. Unpublished. Oregon Department of Fish and Wildlife, Fish Research Project October 1999-September 2000. Annual Progress Report, Portland.

Scheerer, P. D., P.S. Kavanagh, and K. K. Jones. 2004. Oregon chub investigations. Oregon Department of Fish and Wildlife, Fish Research Project EF-03 VII-1, Annual Progress Report, Salem.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14:448-457.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho.

Scoppettone, G.G. and G. Vineyard. 1991. Life history and management of four endangered lacustrine suckers. Pp. 359-377 *in:*W.L. Minckley and J.E. Deason (eds.). Battle against extinction: Native fish management in the American West. University of Arizona Press, Tucson, Arizona.

Sedell, J. R. 1984. Habitats and salmonid distribution in pristine, sediment-rich valley systems: S. Fork Hoh and Queets River, Olympic National Park," pp. 33-46 *in* Meehan, W. R., T. R. Merrell, and T. A. Hanley, eds., Fish and Wildlife Relationships in Old-Growth Forests, American Institute of Fishery Research Biologists, December, 1984.

Sedell, J.R., and J.L. Froggatt. 1984. Importance of streamside forests to large rivers: The isolation of the Willamette River, Oregon, USA from its floodplain by snagging and streamside forest removal. Internationale Vereinigung für Theoretische und angewandte Limnologie Verhandlungen 22:1828-1834.

Sedell, J.R., and F.H. Everest. 1990. Historic changes in habitat for Columbia River Basin salmon under study for TES listing. Draft Report, U.S. Forest Service, Pacific Northwest Research Station, Corvallis, Oregon.

Sedell, J.R., G.H. Reeves, F.R. Hauer, J.A. Stanford, and C.P. Hawkins. 1990. Role of refugia in recovery from disturbances: modern fragmented and disconnected river systems. Environmental Management 14:711-724.

Sedell, J.R., and F.H. Everest. 1991. Historic changes in poo1 habitat for Columbia River Basin salmon under study for TES listing. Draft U.S. Department of Agriculture Report, PacificNorthwest Research Station, Corvallis, Oregon.

Sedgewick, J.A., and F.L. Knopf. 1991. Prescribed grazing as a secondary impact in a western riparian floodplain. J. Range Manage. 44:369-

Sexauer, H.M., and P.W. James. 1997. Microhabitat use by juvenile trout in four streams located in the eastern Cascades, Washington. Pages 361-370 *in* W.C. Mackay, M.K. Brewin and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Shared Strategy for Puget Sound. 2007. Puget Sound salmon recovery plan. Volume 1, recovery plan. Shared Strategy for Puget Sound. Seattle.

Sheer, M.B. and E.A. Steel. 2006. Lost watersheds: barriers, aquatic habitat connectivity, and salmon persistence in the Willamette and lower Columbia River basins. Transactions of the American Fisheries Society 135 (6):1654-1669.

Sherwood, C.R., D.A. Jay, R.B. Harvey, P. Hamilton, and C.A. Simenstad. 1990. Historical changes in the Columbia River estuary. Progress in Oceanography 25(1-4):299-352. doi:http://dx.doi.org/10.1016/0079-6611(90)90011-P.

Sheldon, A.I. 1998. Conservation of stream fishes: patterns of diversity, rarity, and risk. Conservation Biology. 2:149-156.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University Press of Idaho. Moscow, Idaho.

Smith, G.R. 1978. Biogeography of intermountain fishes. Great Basin Nat. Mem. 2:17-42

Smith, G.R., T. Steinback, and G. Pampush. 1984. Distribution, foraging relationships and colony dynamics of the American white pelican (Pelecanus erythrorhynchos) in southern Oregon and northeastern California. Oregon Department of Fish and Wildlife Nongame Wildlife Program Technical Report 83-0-04.

Spence, B.C., G.A. Lomnicky, R.M. Hughs, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR. (Available from the National Marine Fisheries Service, Portland, Oregon.).

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of Bull trout populations. Ecology of Freshwater Fish 8:114-121.

Spruell, P., A.R. Hemmingsen, P.J. Howell, N. Kanda, and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4:17-29

SSPS. 2007. Puget Sound salmon recovery plan. Volume 1, recovery plan. Shared Strategy for Puget Sound. Seattle, Washington.

State of Oregon Department of Administrative Services. 2010. Oregon's Demographic Trends. February 2010.

State of Washington Office of Fianancial Management. 2011. Forecast of the State population: November 2011 Forests. Forecasting Division. 2011.

Stewart, D.B., N.J. Mochnacz, C.D. Sawatzky, T.J. Carmichael, and J.D. Reist. 2007. Fish life history and habitat use in the Northwest territories: Bull trout (*Salvelinus confluentus*). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2801. Department of Fisheries and Oceans, Winnipeg, MB, Canada, 2007, 54 pp.

Stout, H.A., P.W. Lawson, D. Bottom, T. Cooney, M. Ford, C. Jordan, R. Kope, L. Kruzic, G. Pess, G. Reeves, M. Scheuerell, T. Wainwright, R. Waples, L. Weitkamp, J. Williams, and T. Williams. 2011. Scientific conclusions of the status review for Oregon Coast coho salmon (*Oncorhynchus kisutch*). Draft revised report of the Oregon Coast Coho Salmon Biological Review Team. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle.

Strobel, B., D.R. Shively, and B.B. Roper. 2009. Salmon carcass movements in forest streams. Transactions of the American Fisheries Society 29 (3):702-714.

Swanson, F.J. and G.W. Lienkaemper. 1978. Physical consequences of large organic debris in pacific northwest streams. USDA Forest Service, Gen. Tech. Rep., PNW-69.

Swanson, F.J., Gregory, S.V., Sedell, J.R., and A.G. Campbell. 1982. Land-water interactions: the riparian zone. In: Edmonds, R.L., ed. Analysis of coniferous forest ecosystems in the western United States. Stroudsburg, PA: Hutchinson Ross. 267-291.

Swanston, D.N. 1991. Natural processes. Am. Fish. Soc. Sp. Pub. 19:139-179.

Tagart, J. V. 1984. Coho survival from egg deposition to fry emergence. Pages 173-181 *in* J. M. Walton and D. B. Houston, editors. Proceedings of the Olympic Wild Fish Conference, Port Angeles, Washington, March 1983. Peninsula College, Fisheries Technical Program, Port Angeles, Washington.

Taylor, B.E., S. Pollard, and D. Louie. 1999. Mitochondrial DNA variation in bull trout (*Salvelinus confluentus*) from northwestern North America: implications for zoogeography and conservation. Molecular Ecology 8:1155-1170.

Testa, N. 2006. Pers. Comm.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Tonina, D. and J.M. Buffington. 2009. Hyporheic exchange in mountain rivers: mechanics and environmental effects. Geography Compass 3/3:1063-1086.

UCSRB. 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf.

U.S. Army Corps of Engineers (USACE). 1994. Riparian Zone Ecology, Restoration, and Management. Notebook contents. Billings, Montata, June 14-17, 1994. U.S. Army Engineer, Waterways Experiment Station, Natural Resources Division, Vicksburg. MS.

U.S. Department of Agriculture and U.S. Department of Interior (USDA and USDI). 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl. Forest Service and Bureau of Land Management. Portland, OR.

U.S. Department of Agriculture and U.S. Department of Interior (USDA and USDI). 1995a. Decision of Notice and Finding of No Significant Impact for the Inland Native Fish Strategy: Interim Strategies for Managing Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada (INFISH).

U.S. Department of Agriculture and U.S. Department of Interior (USDA and USDI). 1995b. Decision Notice/Decision Record for Interim Strategies for Managing Anadromous Fish-Producing Watersheds on Federal Lands in Eastern Oregon and Washington, Idaho and Portions of California (PACFISH).

USDA and USDI (U.S. Department of Agriculture and U.S. Department of Interior). 2000. Final Supplemental Environmental Impact Statement for Amendment to the Survey & Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines. Portland OR.

USDC (U.S. Department of Commerce). 2004. Endangered and threatened species; establishment of species of concern list, addition of species to species of concern list, description of factors for identifying species of concern, and revision of candidate species list under the Endangered Species Act. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 69(73):19975-19979.

USDC (U.S. Department of Commerce). 2007. Endangered and threatened species: Final listing determination for Puget Sound steelhead. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 72(91):26722-26735.

USDC (U.S. Department of Commerce). 2009. Endangered and threatened species; recovery plans for Lake Ozette sockeye salmon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 74(102):25706-25710.

USDC (U.S. Department of Commerce). 2010. Endangered and threatened wildlife and plants, final rulemaking to establish take prohibitions for the threatened southern distinct population segment of North American green sturgeon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 75(105):30714-30728.

USDC (U.S. Department of Commerce). 2011. Endangered and threatened species: Designation of critical habitat for the southern distinct population segment of eulachon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 76(203):65324-65352.

USFS (U.S. Forest Service). 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings. USDA Forest Service. National Technology and Development Program. 7700—Transportation Mgmt. 0877 1801—SDTDC. August 2008. http://stream.fs.fed.us/fishxing/aop_pdfs.html

USGCRP. 2009. Global climate change impacts in the United States. U.S. Global Change Research Program. Washington, D.C. 188 p. http://waterwebster.org/documents/climate-impacts-report.pdf.

USDI (U. S. Department of Interior). 1985a. Endangered and threatened wildlife and plants; determination that the Warner sucker is a threatened species and designation of critical habitat. Federal Register 50:39117-39123.

USDI (U. S. Department of Interior). 1985b. Determination of threatened status for Hutton tui chub and Foskett speckled dace. U.S. Fish and Wildlife Service. Federal Register 50:12302-12306

USDI (U. S. Department of Interior). 1987. Recovery plan for the Borax Lake chub, *Gila boraxobius*. U.S. Fish and Wildlife Service, Portland, Oregon. 61 pp.

USDI (U.S. Department of Interior). 1988. Endangered and threatened wildlife and plants: Determination of endangered status for the shortnose sucker and Lost River sucker. Federal Register 53 (137): 27130-27134.

USDI (U. S. Department of Interior). 1992. Klamath River basin amendment to the long-range plan for the Klamath River basin conservation area fishery restoration program. Prepared for the Klamath River Basin Fisheries Task Force with assistance from William Kier Associates. Region 1, U.S. Fish and Wildlife Service, Portland, Oregon.

USDI (U.S. Department of Interior). 1993. Lost River and shortnose sucker recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 101 p.

USDI (U.S. Department of Interior). 1998a. Candidate and listing priority assignment form: bull trout in the Klamath River and Columbia River Bull Trout Population Segments.

USDI (U.S. Department of Interior). 1998b. A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale. U.S. Fish and Wildlife Service.

USDI (U. S. Department of Interior). 1998c. Recovery Plan for the Native Fishes of the Warner Basin and Alkali Subbasin. United States Fish and Wildlife Service. Portland, Oregon. 86pp.

USDI (U.S. Department of Interior). 1999. Endangered and threatened wildlife and plants; determination of threatened status for bull trout in the coterminous United States; final rule. Notice of intent to prepare a proposed special rule pursuant to section 4(d) of the Endangered Species Act for the bull trout; proposed rule. Fish and Wildlife Service. November 1, 1999. Federal Register Vol. 64:58910.

USDI (U.S. Department of Interior). 2011a. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Lost River Sucker and Shortnose Sucker. Federal Register 76 (235): 76337-76355.

USDI (U.S. Department of Interior). 2011b. Draft Revised Recovery Plan for the Lost River Sucker (*Deltistes luxatus*) and Shortnose sucker (*Chasmistes brevirostris*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. 112 p.

USFWS (U.S. Fish and Wildlife Service). 1998. Bull Trout Facts. Portland, OR

USFWS (U.S. Fish and Wildlife Service). 2002a. Bull trout (*Salvelinus confluentus*) draft recovery plan - Chapter 1: Introduction. U.S. Fish and Wildlife Service, Portland, Oregon, October, 2002, 137 pp.

USFWS (U.S. Fish and Wildlife Service). 2002b. Bull trout (*Salvelinus confluentus*) draft recovery plan - chapter 2 Klamath River. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2002c. Bull trout (*Salvelinus confluentus*) draft recovery plan - Chapter 25 Saint Mary- Belly River. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2002d. Chapter 20 of the bull trout (Salvelinus confluentus) draft recovery plan: Lower Columbia Recovery Unit, Washington. USFWS, Region 1, Portland, Oregon, 102 pp.

USFWS (Fish and Wildlife Service). 2004a. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (Fish and Wildlife Service). 2004b. Draft Recovery Plan for the Jarbidge Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (Fish and Wildlife Service). 2005. Chapter 5, Willamette River Recovery Unit, Oregon. 147 p. *In*: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2007a. Lost River sucker (Deltistes luxatus) 5-year review summary and evaluation. Klamath Falls, Oregon. 38 pp.

USFWS (U.S. Fish and Wildlife Service). 2007b. Shortnose sucker (Chasmistes brevirostris) 5-year review summary and evaluation. Klamath Falls, Oregon. 39 pp.

USFWS (Fish and Wildlife Service). 2008. Bull trout draft core area templates - complete core area by core area analysis. W. Fredenberg and J. Chan, *editors*. U. S. Fish and Wildlife Service. Portland, Oregon. 1,895 pages.

USFWS (U.S. Fish and Wildlife Service). 2009. Modoc sucker (Catostomus microps) 5-year review summary and evaluation. Klamath Falls, Oregon. 33 pp.

USFWS (U.S. Fish and Wildlife Service). 2010. Best management practices to minimize adverse effect to Pacific Lamprey. http://www.fws.gov/columbiariver/publications/BMP_Lamprey_2010.pdf

USFWS (U.S. Fish and Wildlife Service). 2011. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E065

USFWS and NMFS (Fish and Wildlife Service and National Marine Fisheries Service). 1998. Endangered Species Consultation Handbook: Proceedures for conducting consultation and conference activities under section 7 of the Endangered Species Act.

UCSRB. 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf.

Wainwright, T.C., M.W. Chilcote, P.W. Lawson, T.E. Nickelson, C.W. Huntington, J.S. Mills, K.M.S. Moore, G.H. Reeves, H.A. Stout, and L.A. Weitkamp. 2008. Biological recovery criteria for the Oregon Coast coho salmon evolutionarily significant unit. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-NWFSC-91. Seattle. http://docs.lib.noaa.gov/noaa_documents/NMFS/NWFSC/TM_NMFS_NWFSC/TM_NMFS_NWFSC_91.pdf

Waples, R.S. 1999. Dispelling some myths about hatcheries. Fisheries 24(2):12-21.

Waples, R.S., O.W. Johnson, and R.P. Jones, Jr. 1991. Status review for Snake River sockeye salmon. U.S. Department of Commerce, NOAA Technical Memo, National Marine Fisheries Service NMFS F/NWC-195.

Waples, R.S., R.P. Jones, Jr., B.R. Beckman, and G.A. Swan. 1991b. Status review for Snake River fall Chinook salmon. U.S. Department of Commerce, NOAA Technical Memo. National Marine Fisheries Service F/NWC-201.

Waples, R.S., P.B. Aebersold and G.A. Winans. 1997. Population genetic structure and life history variability in *Oncorhynchus nerka* from the Snake River basin. Report to Bonneville Power Administration, Contract No. 1993BP05326, Project No. 199306800. BPA Report DOE/BP-05326-1.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: and investigation at hierarchical scales. North American Journal of Fisheries Management 17:237-252.

WDNR (Washington Department of Natural Resources). 2000. Changing Our Water Ways - Trends in Washington's Water Systems.

WDF, WDW, and WWTIT (Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes). 1993. Washington state salmon and steelhead stock inventory (SASSI), 1992. Washington Department of Fisheries, Washington Department of Wildlife and Western Washington Treaty Indian Tribes. Olympia.

WDFW (Washington Department of Fish and Wildlife). 1997. Washington Department of Fish and Wildlife hatcheries program. Operations program - Lewis river complex for January 1, 1997 to December 31,1997. Washington Department of Fish and Wildlife, Olympia, WA.

WDFW (Washington Department of Fish and Wildlife). 1998. Washington State salmonid stock draft inventory: bull trout/Dolly Varden. Washington Department of Fish and Wildlife, Olympia, WA.

WDFW (Washington Department of Fish and Wildlife). 2009. Fish passage and surface water diversion screening assessment and prioritization manual. Washington Department of Fish and Wildlife. Olympia, Washington.

WDFW and ODFW (Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife). 2001. Joint state eulachon management plan. Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife.

WDFW and Point No Point Treaty Tribes. 2007. Five-year review of the summer chum salmon conservation initiative: Supplemental report no. 7, summer chum salmon conservation initiative – an implementation plan to recover summer chum in the Hood Canal and Strait of Juan de Fuca Region. Washington Department of Fish and Wildlife. Olympia, Washington.

WDNR (Washington Department of Natural Resources). 2000. Changing Our Water Ways - Trends in Washington's Water Systems.

WDOE (Washington Department of Ecology). 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oyxgen: Draft discussion paper and literature summary. Publication Number 00-10-071. Washington Department of Ecology, Olympia, WA, 90 pp.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, NOAA Technical Memorandum, NMFS-NWFSC-24. 258 p. http://www.nwfsc.noaa.gov/assets/25/4237_06172004_123333_coho.pdf.

Wemple, B.C., J.A. Jones, and G.E. Grant. 1996. Channel network extension by logging roads in two basins, western cascades, Oregon. Water Resources Bulletin 32(6):1195-1207.

Wentz, D.A., B.A. Bonn, K.D. Carpenter, S.R. Hinkle, M.L. Janet, F.A. Rinella, M.A. Uhrich, I.R. Waite, A. Laenen, and K.E. Bencala. 1998. Water quality in the Willamette Basin, 1991-1995. U.S. Geological Survey Circular 1161. May 20. http://pubs.usgs.gov/circ/circ1161/.

White, R.K., T.R. Hoitsma, M.A. Stern, and A.V. Munhall. 1990. Final report on investigations of the range and status of the Warner sucker (*Catostomus warnerensis*) during spring and summer 1990. Unpublished report to Bureau of Land Management, Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife. 66 pp.

Whiteley, A.R., P. Spruell, F.W. Allendorf. 2003. Population Genetics of Boise Basin Bull Trout (*Salvelinus confluentus*). University of Montana, Division of Biological Sciences. Report to the U.S. Forest Service, Rocky Mountain Research Station, Boise, ID.

Whitesel, T.A. and 7 coauthors. 2004. Bull trout recovery planning: A review of the science associated with population structure and size. Science Team Report #2004-01, U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

Wilcox, J., T. Benoit, and L. Mink. 2001. Evaluation of geomorphic restoration techniques applied to fluvial systems. Feather River Resource Management Group, Plumas Corporation, State of California Water Resources Control Board, University of California Cooperative Extension, and Northwest California-based Collaborative Learning Circle. December. http://www.feather-river-crm.org/project-files/georest/cover.html.

Williams, R.N. 1991. Genetic analysis and taxonomic status of cutthroat trout from Willow Creek and Whitehorse Creek in southeastern Oregon. BSU Evolutionary Genetics Lab Report 91-3. Boise, ID. 15pp.

Williams, J. E. & C. E. Bond. 1980. *Gila boraxobius*, a new species of cyprinid fish from southeastern Oregon with a comparison to *G. alvordensis Hubbs* and Miller. Proceedings of the Biological Society of Washington. 93:291-298.

Williams, J.E., M.A. Stern, A.V. Munhall, and G.A. Anderson. 1990. Conservation status of the threatened fishes of the Warner Basin, Oregon. Great Basin Naturalist 50(3):243-248.

Williams, T.H., E.P. Bjorkstedt, W.G. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, M. Rode, R.G. Szerlong, R.S. Schick, M.N. Goslin, and A. Agrawal. 2006. Historical population structure of coho salmon in the Southern Oregon/Northern California coasts evolutionarily significant unit. U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-390, 71 p.

Williams, T.H., B.C. Spence, W. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, T.E. Nickelson, E. Mora, and T. Pearson. 2008. Framework for assessing viability of threatened coho salmon in the Southern Oregon/Northern California coast evolutionarily significant unitU.S. Department of Commerce, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-432. La Jolla, California. 96 p. http://swfsc.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-432.pdf.

Wimberly, M.C., T.A. Spies, C.J. Long, and C. Whitlock. 2000. Simulating historical variability in the amount of old forests in the Oregon Coast Range. Conservation Biology 14(1):167-180. <Go to ISI>://000085366700022.

Wipfli, M.S., J.P. Hudson, D.T. Chaloner, and J.P. Couette. 1999. Influence of salmon spawner densities on stream productivity in southeast Alaska. Canadian Journal of Fisheries and Aquatic Sciences 56:1600–1611.

Wissmar, R.C., J.E. Smith, B.A. McIntosh, H.W. Li, G.H. Reeves, and J.R. Sedell. 1994. Ecological health of river basins in forested regions of eastern Washington and Oregon. General Technical Report PNW-GTR-326, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon. http://www.fs.fed.us/pnw/publications/gtr326/pnw_gtr326a.pdf

Wright, S. 2004. Petition to list Puget Sound steelhead (anadromous Oncorhynchus mykiss) as an endangered or threatened species under the Endangered Species Act (ESA). Letter submitted to the Secretary of Commerce, 13 Sept. 2004, 12p.

WWF (World Wildlife Fund). 2003. Buying time: a user's manual for building resistance and resilience to climate change in natural systems. Editors: L.J. Hansen, J.L Biringer, and J.R. Hoffman.

Wydoski, R.S. 1978. Responses of trout populations to alterations in aquatic environments: a review. Pages 57-92 in J.R. Moring, ed. Proceedings of the wild trout-catchable trout symposium, Eugene, OR. Feb. 15-17, 1978.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200. doi:10.1111/j.1523-1739.2006.00300.xVannote, R.L., Minshall, G.W., Cummins, K.W., Sedell, J.R., and C.E. Cushing. 1980. The river continuum concept. Can. J. For. Res. 20:1593-1601.

Ziller, J.S. 1992. Distribution and relative abundance of bull trout in the Sprague River subbasin, Oregon. Pages 18-29 *in* Howell, P.J. and D.V. Buchanan, eds., Proceedings of the Gearhart Mountain bull trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

VII. References (Terrestrial)

Almack, J.A., W.L. Gaines, P.H. Morrison, J.R. Eby, R.H. Naney, G.F. Wooten, M.C. Snyder, S.H. Fitkin, and E.R. Garcia. 1993. North Cascades Grizzly Bear Ecosystem Evaluation: Final Report. Interagency Grizzly Bear Committee, Denver, CO.

Almack, J.A. and S.H. Fitkin. 1998. Grizzly bear and gray wolf investigations in Washington State 1994-1995. Final Progress Report. Washington Dept. of Fish and Wildlife, Olympia, WA. 80 pp.

Amsberry, K. 2001. Pers. comm. Oregon Department of Agriculture, Corvallis, Oregon.

Amsberry K. and R.J. Meinke. 2002. Reproductive Ecology of *Fritillaria gentneri*. Report from Oregon Department of Agriculture. Portland (OR): US Fish and Wildlife Service. 41 p.

Apps, C.D. 2000. Space-use diet, demographics, and topographic associations of lynx in the Southern Canadian Rocky Mountains: a study. Pages 351-371 *In*: Ruggerio et al Ecology and conservation of lynx in the United States. GTR-30WWW University Press of Colorado and the USDA, Rocky Mountain Research Station. 480 pp.

Aubry K.B., Koehler, G.M., Squires, J.R. 2000. Ecology of Canada lynx in Southern Boreal Forests. In: Ecology and Conservation of Lynx in the United States (eds. Ruggiero LF et al.), pp. 373–396. University Press of Colorado, Boulder, Colorado.

Audet, Suzanne. 2002. Pers. Comm. Wildlife Biologist, USDI Fish and Wildlife Service, Spokane, WA.

Borgias, D. 2004. Pers. comm.

Borysewicz, Michael. 2003. Personal communication. Wildlife Biologist, Colville National Forest. March 12, 2003.

Boyd, R. 1986. Strategies of Indian burning in the Willamette Valley. Canadian Journal of Anthropology 5:67-86.

Brock, R., and B. Knapp. 2000. *Fritillaria gentneri* demographic study plots at Jacksonville Woodlands, 2000 data, second year. Unpublished report submitted to the Bureau of Land Management, Medford District. 12 p

Burger, A.E. 2002. Conservation assessment of marbled murrelets in British Columbia, a review of biology, populations, habitat associations and conservation. Pacific and Yukon Region, Canadian Wildlife Service. 168 pages.

Buskirk, S.W. L.F. Ruggiero, K.B. Aubry, D.E. Pearson, J.R. Squired, and K.S. McKelvey. 2000. Comparative ecology of lynx in North America. Pages 397-417 *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, and others. Ecology and conservation of lynx in the United States. Univ. Press of Colorado. 480 pp.

Cannon, K. 2002. Pers. comm.

Caswell, H. and T.N. Kaye. 2001. Stochastic demography and conservation of an endangered perennial plant (*Lomatium bradshawii*) in a dynamic fire regime. Advances in Ecological Research 32:1-51.

Chapman, R.C. 1979. Effects of human disturbance on wolves. MS Thesis. Univ. of Alaska, Fairbanks, AK.

CH2M Hill. 1996. Studies of *Sidalcea nelsoniana.* Unpublished annual research reports and technical memoranda prepared by CH2M Hill for McMinnville Water and Light, submitted to the Service.

Clark, D. L. 2000. Demographic analysis of *Erigeron decumbens var. decumbens*, an endangered plant species of the Willamette Valley, Oregon: 1999 Field Studies. U.S. Fish and Wildlife Service, Western Oregon NWR Refuge Complex. Order No. 1448-13590-9-M047A.

Clark, D.L., Finley, K.K., C.A. Ingersoll. 1993. Status report for Erigeron decumbens var. decumbens. Unpublished report prepared for the Conservation Biology Program, Oregon Department of Agriculture. p.55+.

Clark, D. L., K. K. Finley, C. A. Ingersoll. 1995. Regeneration biology of *Erigeron decumbens var. decumbens*, an endangered plant of the Willamette Valley. Report to the Oregon Department of Agriculture

Clark, D.L., C. A. Ingersoll, C.A., and K. K. Finley. 1997. Regeneration of *Erigeron decumbens var. decumbens (Asteraceae)*, the Willamette daisy. Pages 41-47 in T. N. Kaye et al. (eds.), Conservation and Management of Native Plants and Fungi. Native Plant Society of Oregon

Davis, J.S. and B. Youtie. 1995. Site information and analysis: North Powder *Thelypodium howellii ssp. spectabilis* preserve.Prepared for The Nature Conservancy, Oregon Field Office, Portland, OR.

Dolbeer, R.A. and W.R. Clark. 1975. Population ecology of snowshoe hares in the central Rocky Mountains. Journal of Wildlife Management 39: 535-549.

Drew, A. D. 2000. Effects of livestock grazing and small mammal populations on endangered Bradshaw's desert parsley (*Lomatium bradshawii*) at Oak Creek, Willamette Valley, Oregon. M.S. Thesis. University of Oregon, Eugene. 65 pp.

Eastman, D.C. 1990. Rare and Endangered Plants of Oregon. Beautiful America Publishing Company. 194p

Evans, H.F. 1960. A preliminary investigation of caribou in the northwestern United States. M.S . Thesis, Montana State Univ., Missoula. 145 pp.

Evans, D.E., W.P. Ritchie, S.K. Nelson, E. Kuo-Harrison, P. Harrison, and T.E. Hamer. 2003. Methods for surveying marbled murrelets in forests: a revised protocol for land management and research. Pacific Seabirds Group unpublished document available at http://www.pacificseabirdgroup.org.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: an ecological, economic, and social assessment. Portland, OR: U.S. Department of Agriculture; U.S Department of Interior [and others]. [irregular pagination].

Franklin J. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Freddy, D.J. 1974. Status and management of the Selkirk caribou herd, 1973. Unpublished M.S. Thesis, University of Idaho, Moscow, ID.

Gilpin, M.E. and M.E, Soule. 1986. Minimum viable populations: Processes of species extinction. In Conservation Biology: The Science of Scarcity and Diversity, ed. M.E. Soule, pp 19-34. Sinauer, Sunderland, Mass.

Gisler SD and R.J. Meinke. 1997. Reproductive attrition by predispersal seed predation in *Sidalcea nelsoniana Malvaceae*: Implications for the recovery of a threatened species. In Kaye TN, Liston A, Love RM, Luoma DL, Meinke RJ, Wilson MV, editors. Conservation and management of native plants and fungi. Corvallis (OR): Native Plant Society of Oregon.

Guerrant, E. O. Jr. 1996. Designing populations: Demographic, Genetics, and Horticultural Dimensions. In Falk, D. A., C. I. Miller, and M. Olwell (eds.). Restoring Diversity: Strategies for Reintroduction of Endangered plants. Island Press, New York.

Guerrant, E. O. Jr. 2004. Pers. comm.

Hammond, P. C. 1994. 1993 study of the Fender's blue butterfly (Icaricia icarioides fenderi) in Benton, Polk and Yamhill Counties. U.S. Fish and Wildlife Service, Portland, Oregon.

Hammond, P. C. 1996. 1995 study of the Fender's blue butterfly (Icaricia icarioides fenderi) in Benton, Polk and Yamhill Counties. U.S. Fish and Wildlife Service, Portland, Oregon.

Hammond, P. C. 1998. 1997 study of the Fender's blue butterfly (Icaricia icarioides fenderi) in Benton, Polk and Yamhill Counties, Oregon. U.S. Fish and Wildlife Service, Portland, Oregon.

Hammond, P.C. and M.V. Wilson. 1993. Status of the Fender's blue butterfly, Unpublished report on file at U.S. Fish and Wildlife Service, Oregon State Office. 66pp.

Helm, B. P. 1998. Biogeography of Eight Large Branchiopods Endemic to California, in Witham, C. W., Bauder, E. T., Belk, D., Ferren Jr., W. R., and Ornduff, R. (eds.), Ecology, conservation, and management of vernal pool ecosystems, California Native Plant Society, Sacramento, CA.

Hitchcock, C. L. et al. 1955–1969. Vascular plants of the Pacific Northwest.

Horstman, A. 2004. Pers. comm.

Imper, D. K., and J. 0. Sawyer. 1994 (October). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1994 Monitoring Report Western Lily. Unpublished Report Prepared under Interagency Agreement. California State University/California Department of Fish and Game. With 2 attachments.

Imper, D.K. 2005. Pers. comm.

Ingersoll, C.A.; Finley, K.K.; Clark, D.L. 1995. Demography and Reproduction of *Erigeron decumbens var. decumbens*, 1993-1994 Field Studies. Prepared for the Oregon Department of Agriculture, Plant Conservation Biology Program. p.28.

Jain, S.K. 1978. Local dispersal of *Limnanthes* nutlets: an experiment with artificial vernal pools. Canadian Journal of Botany 56: 1995-1997.

Johannessen, C.L., W.A. Davenport, A. Millet, and S. McWilliams. 1971. The vegetation of the Willamette Valley. Ann. Assoc. Am. Geogr. 61:286-302.

Kagan, J.S. 1980. The biology of *Lomatium bradshawii* (*Apiaceae*), a rare plant of Oregon. M.S. thesis, University of Oregon, Eugene.

Kagan, J.S. 1986a. Status report for *Thelypodium howellii ssp. spectabilis*. Oregon Natural Heritage Data Base, Portland, Oregon.

Kagan, J.S. 1986b. A new species of *Lomatium* (Apiaceae), from southwestern Oregon. Madroño 33: 71-75b.

Kagan, J.S. and S. Yamamoto. 1987. Status Report for Erigeron *decumbens subsp. decumbens* (Draft). Oregon Natural Heritage Data Base. p.30+.

Katnik, D.D. 2002 Predation and habitat ecology of mountain lions (*Puma concolor)* in the southern Selkirk Mountains. Doctoral Dissertation Washington State University. 240 pp.

Kaye, T. 1992. Bradshaw’s desert-parsley: population monitoring and pollination biology. Unpublished manuscript submitted to Kalmiopsis, from Restoration and Conservation Biology Cooperative Project (OSU and ODA), Corvallis, OR.

Kaye, T.N. and M. Kirkland. 1994. *Cimicifuga elata*: status, habitat analysis, monitoring, inventory, and effects of timber management. Final report. A Cooperative ChallengeCost Share Report between Oregon Department of Agriculture, U.S. Bureau of Land Management, and U.S. Forest Service.

Kaye, T.N.; Kuykendall, K.; Nelson, C. 2000. Seedling and transplanting rare Willamette Valley prairie plants for population restoration. Challenge Cost Share Project funded jointly by the Bureau of Land Management, Eugene District and the Institute for Applied Ecology. p.42.

Kaye, T.N. and K. Kuykendall. 2001. Germination and propagation techniques for restoring rare Pacific Northwest prairie plants. In, Reichard, S.H., P.W. Dunwiddie, J.G. Gamon, A.R. Kruckeberg, D.L. Salstrom, editors. Conservation of Washington's Native Plants and Ecosystems. Washington Native Plant Society, Seattle, Washington.

Kaye, T.N., M.V. Wilson, T. Erhart, P.C. Hammond, K. Kuykendall, A. Liston, A.F. Robinson, Jr., C.B. Schultz, and P.M. Severns. 2003. Biology of Kincaid's lupine (Lupinus sulphureus ssp. kincaidii [Smith] Phillips), a threatened species of western Oregon native prairies. Natural Areas Journal 23:72-83

Kaye, T. N., and A. Brandt. 2005. Seeding and transplanting rare Willamette Valley prairie plants for population restoration. Unpublished report to the Eugene District BLM. Institute for Applied Ecology, Corvallis, Oregon.

Kline, B. 1984. Cultivating West coast lilies. Journal of the North American Lily Society. 38(3): 11-13

Koehler, G.M. 1990. Population and habitat characteristics of lynx and snowshoe hares in north central Washington. Canadian Journal of Zoology 68:845-851

Koehler, G.M. and K.B. Aubry. 1994. Lynx. In: Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski. 1994. The scientific basis for conserving forest carnivores: American marten, fisher, lynx and wolverine in the western United States. USDA Forest Service, Rocky Mountain Forest and Range Experimental Station, General Technical Report RM-254.

Kuykendall, K. and T.N. Kaye. 1993. *Lupinus sulphureus ssp. kincaidii* survey and reproduction studies. U.S. Bureau of Land Management, Roseburg District, Roseburg, Oregon and Oregon Department of Agriculture, Salem, Oregon. 44 pp.

Lawrence, B. A. 2005. Studies to facilitate the reintroduction of golden paintbrush (*Castilleja levisecta*) to the Willamette Valley, Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon.

Leininger, S. 2001. Promoting and restoring Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*) and Willamette daisy (*Erigeron decumbens var. decumbens*) at Baskett Slough NWR. Senior honors Thesis, Oregon State University

Mancuso M. 2011. A range-wide monitoring program for Macfarlanes's Four-o-Clock (Mirabilis macfarlanei), a threatened plant species in Idaho and Oregon. Report prepared by Mancuso Botanical Services for Snake River Fish and Wildlife Office, Boise, Idaho.

McKelvey K.S. 2000. History and distribution of lynx in the contiguous United States. *In:* Ruggerio et al. Ecology and conservation of lynx in the United States. University Press of Colorado and the USDA, Rocky Mountain Research Station. 480 pp.

Meinke, R.J. 1982. Threatened and endangered vascular plants of Oregon: an illustrated guide. Unpublished report by the Oregon Department of Agriculture for the U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. 352 pp.

Mousseaux, M. 2004. Pers. comm.

Murray, D.L., S. Boutin and O'Donoghue. 1994. Winter habitat selection by lynx and coyotes in relation to snowshoe hare abundance. Canadian Journal of Zoology 72:1444-1451.

Nelson, S.K., and A.K. Wilson. 2002. Marbled murrelet habitat characteristics on state lands in western Oregon. Corvallis, OR, Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Department of Fisheries and Wildlife, 151 pp.

Olterman, J.H. and B.J. Verts. 1972. Endangered plants and animals of Oregon *IV. Mammals.* Oregon State University, Agricultural Experiment Station, Special Report, 364:1-47

Oregon Department of Fish and Wildlife (ODFW). 2005. Oregon Wolf Conservation and Management Plan. 189 pages. Portland, Oregon

Parker, G.R., J.W. Maxwell, L.D. Morton, and G.E.J. Smith. 1983. The ecology of the lynx (*Lynx canadensis*) on Cape Breton Island. Can. J. Zoology 61:770-786.

Peterson, R.O. 1986. Gray Wolf. *In* R.L. Di Silvestro, ed., Audubon Wildlife Report 1986. National Audubon Soc., New York

Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (eds). 1995. Ecology and conservation of the marbled murrelet. Gen. Tech. Rept. PSW-GTR- 152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Dept. Of Agriculture. 420 pp.

Ruediger, B., J. Claar, S. Gniadek, B. Holt, L. Lewis, and 10 others. 2000. Canada lynx conservation assessment and strategy. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, USDI National Park Service. Forest Service Publication #R1-00-53, Missoula, MT. 142 pp.

Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires. 2000. Ecology and conservation of lynx in the United States. Univ. Press of Colorado and USDA Rocky Mountain Research Station. 480 pp.

Schultz, C. B. 1997. Status of the Fender's blue butterfly (Icaricia icarioides fenderi) in Lane County, Oregon: population estimates and site evaluations. U.S. Fish and Wildlife Service, Portland, Oregon.

Schultz, C. B. 1998. Dispersal behavior and its implications for reserve design in a rare Oregon butterfly. Conservation Biology 12:284-292.

Schultz, S. T. 1989 (September). Status Report on *Lilium occidentale Pard*. Unpublished report prepared for the Endangered Species Program, Plant Division, Oregon State Department of Agriculture, Salem, Oregon.

Schultz, C. B., and E. E. Crone. 1998. Burning prairie to restore butterfly habitat: a modeling approach to management tradeoffs for the Fender's blue. Restoration Ecology 6:244–252.

Schultz, C. B., and K.M. Dlugosch. 1999. Nectar and hostplant scarcity limit populations of and endangered Oregon butterfly. Oecologia 119:231-238.

Scott, M.D. and G. Servheen. 1985. Caribou Ecology. Job Comp. Report, Proj. No. W-160-R11. Idaho Dept. of Fish and Game, Boise. 136 pp.

Siddall, J.L.; Packard, P.L.; Chambers, K.L. 1978. Status Report for *Mentzelia packardiae*. Unpublished report. p.9

Simpson, K. and G.P. Woods. 1987. Movements and habitats of caribou in the mountains of southern British Columbia. Ministry of Environment and Parks Wildlife Bull. No. 8-57.

Skinner, M. W. 1988 (June). Comparative Pollination Ecology and Floral Evolution in Pacific Coast Lilium. Unpublished thesis. Harvard University, Cambridge, MA.

Squires, J.R. and T. Laurion. 2000. Lynx home range and movements in Montana and Wyoming: preliminary results. Pages 337-349 In: Ruggerio et al Ecology and conservation of lynx in the United States. GTR-30WWW University Press of Colorado and the USDA, Rocky Mountain Research Station. 480 pp.

Sullivan, M. 2004. Pers. comm.

Testa, N. 2006. Pers. comm.

Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. Report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. Portland, OR. 427 pp.

Thomas, J.W., M.G. Raphael, R.G. Anthony, E.D. Forsman, A.G. Gunderson, R.S. Holthausen, B.G. Marcot, G.H. Reeves, J.R. Sedell, and D.M. Solis. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest. Portland, Oregon. U.S. Department of Agriculture, Forest Service, 523 pp.

USDA & USDI (U.S. Department of Agriculture and U.S. Department of Interior). 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the range of the northern spotted owl and Standards and Guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl.

USDA & USDI (U. S. Department of Agriculture and U. S. Department of Interior). 2001. Record of decision for amendments to the survey and manage, protection buffer, and other mitigation measures standards and guidelines. Regional Ecosystem Office, Portland, Oregon.

USDI (U.S. Department of Interior). 1978. Endangered and threatened wildlife and plants; determination of threatened for the bald eagle. Final Rule. U.S. Fish and Wildlife Service. Fed. Reg. 43: 6230. February 14, 1978.

USDI (U.S. Department of Interior). 1990. Endangered and threatened wildlife and plants; determination of threatened status for the northern spotted owl. Fed. Reg.55 (123): 26114-26194. June 26, 1990.

USDI (U.S. Department of Interior). 1991. Stephanomeria malheurensis (Malheur Wirelettuce) Recovery Plan. Portland, Oregon. 34pp. http://ecos.fws.gov/docs/recovery_plans/1991/910321.pdf

USDI (U.S. Department of Interior). 1992a. Endangered and threatened wildlife and plants; determination of threatened status for the Washington, Oregon, and California population of the marbled murrelet. Final Rule. Fed. Reg. 57(191): 45328-45337.

USDI (U.S. Department of Interior). 1992b. Endangered and threatened wildlife and plants; Determination of critical habitat for the northern spotted owl. U.S. Fish and Wildlife Service. Fed. Reg. 57:1796-1838.

USDI (U.S. Department of Interior). 1992c. Endangered and threatened wildlife and plants; final rule to list the plant *Spiranthes diluvialis* (Ute Ladies'-Tresses) as a threatened species. Final Rule. Fed. Reg.57(12): 2048-2054. January 17, 1992.

USDI (U.S. Department of Interior). 1993a. Grizzly bear recovery plan. Missoula, MT.

USDI (U.S. Department of Interior). 1993b. Endangered and threatened wildlife and plants; Determination of endangered status for two plants, *Arenaria paludicola* (Marsh Sandwort) and *Rorippa gambellii* (Gambel's Watercress). 1993. Fed. Reg. 58(147): 41378-41384. August 3, 1993.181 pp.

USDI (U.S. Department of Interior). 1993c. *Lomatium bradshawii* (Bradshaw's lomatium) Recovery Plan. Portland, Oregon. 47 pp.

USDI (U.S. Department of Interior). 1993d. Determination of Endangered status for the plant *Astragalus applegatei* (Applegate's milk-vetch). Federal Register. 58, 143: 40547-40551.

USDI (U.S. Department of Interior). 1994. Determination of Endangered Status for *Lilium Occidentale* (Western Lily). Federal Register 59:42171-42176.

USDI (U.S. Department of Interior). 1994a. Recovery plan for woodland caribou in the Selkirk Mountains. Portland, OR. 63 pp.

USDI (U.S. Department of Interior). 1994b. Endangered and threatened wildlife and plants; The plant, Water Howellia (*Howellia aquatilis*), determined to be a threatened species. Fed. Reg. 59(134): 35860-35864. July 14, 1994.

USDI (U.S. Department of Interior). 1996a. Endangered and threatened wildlife and plants; final designation of critical habitat for the marbled murrelet. U.S. Fish and Wildlife Service. Fed. Reg. 61: 26256-26320.

USDI (U.S. Department of Interior). 1996b. Endangered and threatened wildlife and plants; Reclassification of *Mirabilis macfarlanei* (MacFarlane's Four-O'Clock) from endangered to threatened status. Fed. Reg. 61(52): 10693-10697. March 15, 1996.

USDI (U.S. Department of Interior). 1997. Recovery plan for the threatened marbled murrelet *(Brachyramphus marmoratus)* in Washington, Oregon, and California. Portland, OR. 203 pp.

USDI (U.S. Department of Interior). 1998a. Recovery Plan for the Threatened Nelson's Checker-mallow (*Sidaleea nelsoniana)*. U.S. Fish and Wildlife Service. Portland, OR.

USDI (U.S. Department of Interior). 1998b. Recovery Plan for the Endangered Western lily (*Lilium occidentale*). Portland, Oregon. 82 pp.

USDI (U.S. Department of Interior). 1998c. Applegate's milk-vetch (*Astragalus applegatei*) recovery plan. Portland, Oregon: U.S. Fish & Wildlife Service, Pacific Region. p.41

USDI (U.S. Department of Interior). 1999a. Endangered and threatened wildlife and plants; Proposed rule to remove the bald eagle in the lower 48 states from the list of endangered and threatened wildlife. Fed. Reg. 64(128): 36454-36464. July 6, 1999.

USDI (U.S. Department of Interior). 1999b. Final Endangered Status for the Plant *Fritillaria gentneri* (Gentner's fritillary). Federal Register. 64, 237: 69195-69203.

USDI (U.S. Department of Interior). 1999c. Endangered and threatened wildlife and plants; determination of endangered status for *Sidalcea oregana* var. *calva* (Wenatchee Mountains Checker-Mallow). U.S. Fish and Wildlife Service. Fed. Reg. 64(245):71680-71687. December 22, 1999.

USDI (U.S. Department of Interior). 2000. Endangered and threatened wildlife and plants; Determination of Threatened Status for the Contiguous U.S. Distinct Population Segment of the Canada Lynx and Related Rule. U.S. Fish and Wildlife Service. Fed. Reg. 65: 16051-16086.

USDI (U.S. Department of Interior). 2000a. Endangered Status for the Plant *Plagiobothrys hirtus* (Rough Popcornflower). Federal Register. 65, 16: 3866-3875.

USDI (U.S. Department of Interior). 2000b. Proposed Endangered Status for *Erigeron decumbens var. decumbens* (Willamette Daisy) and Fender's Blue Butterfly (*Icaricia icarioides fenderi*) and Threatened Status for *Lupinus sulphureus ssp. kincaidii* (Kincaid's Lupine). Federal Register. 63, 17: 3863-3877

USDI (U.S. Department of Interior). 2000c. Recovery plan for the golden paintbrush (*Castilleja levisecta*). U.S. Fish and Wildlife Service, Portland, Oregon.

USDI (U.S. Department of Interior). 2001a. Endangered and threatened wildlife and plants; Final designation of critical habitat for *Sidalcea oregana var. calva*. Fed. Reg. 66(173): 46536-46548.

USDI (U.S. Department of Interior). 2001b. Endangered and threatened wildlife and plants; Final rule to list *Silene spaldingii* (Spalding's Catchfly) as threatened. Fed. Reg. 66(196): 51598-51606. October 10, 2001.

USDI (U.S. Department of Interior). 2002. Recovery plan for Howell's spectacular thelypody (*Thelypodium howellii spectabilis*). Region 1, U.S. Fish and Wildlife Service, Portland, OR.

USDI (U.S. Department of Interior). 2002a. Endangered and threatened wildlife and plants; Determination of endangered status for the Washington plant *Hackelia venusta* (Showy Stickseed). Fed. Reg. 67(25): 5515-5525. February 6, 2002.

USDI (U.S. Department of Interior). 2002b. Biological Opinion of the Effects of Mt. Baker-Snoqualmie National Forest Program of Activities for 2003-2007 on Marbled Murrelets and Northern Spotted Owls. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, WA. Prepared by Kent Livezey, Cindy Levy, and Mark Hodgkins. FWS Reference Number 1-3-02-F-1583. September 2002.

USDI (U.S. Department of Interior). 2002c. Determination of Endangered Status for *Lomatium cookii* (Cook's Lomatium) and *Limnanthes floccosa ssp. grandiflora (*Large-Flowered Woolly Meadowfoam) From Southern Oregon; Final Rule. Federal Register 67: 68004-68015.

USDI (U.S. Department of Interior). 2003a. Recovery Plan for the Rough Popcornflower (*Plagiobothrys hirtus*). Fish and Wildlife Service. Roseburg, OR.

USDI (U.S. Department of Interior). 2003b. Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon Vernal pool crustaceans and plants in California and Oregon. Portland, Oregon.

USDI (U.S. Department of Interior). 2005. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Fender's Blue Butterfly (*Icaricia icarioides fenderi*), *Lupinus sulphureus ssp. kincaidii* (Kincaid's Lupine), and *Erigeron decumbens var. decumbens* (Willamette Daisy); proposed rule. Federal Register 70: 66492-66599.

USFWS (U.S. Fish and Wildlife Service). 1995. Ute ladies' tresses (*Spiranthes diluvialis*) draft recovery plan. U.S. Fish and wildlife Service, Denver, CO. 46 pp.

USFWS (U.S. Fish and Wildlife Service). 1996. Final rule to reclassify Mirabilis macfarlanei from endangered to threatened status. Federal Register 61 (52): 10693-10697.

USFWS (U.S. Fish and Wildlife Service). 1997. Recovery Plan for the Threatened Marbled Murrelet *(Brachyramphus marmoratus)* in Washington, Oregon, and California. Portland, Oregon. 203 pp.

USFWS (U.S. Fish and Wildlife Service). 1998. Applegate's milk-vetch (Astragalus applegatei) recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 41 pp. **http://ecos.fws.gov/docs/recovery_plans/1998/980410d.pdf**

USFWS (U.S. Fish and Wildlife Service). 2000. Revised recovery plan for Macfarlane's four-o'clock (Mirabilis macfarlanei). Region 1, U.S. Fish and Wildlife Service, Portland, OR. 46 pp.

USFWS (U.S. Fish and Wildlife Service). 2001. Endangered and threatened wildlife and plants; final rule to list Silene spaldingii (Spalding's catchfly) as threatened. Federal Register 66(196): 51598-51606.

USFWS (U.S. Fish and Wildlife Service). 2003. Recovery plan for *Fritillaria gentneri* (Gentner's fritillary). U.S. Fish and Wildlife Service, Portland, Oregon. viii + 89 pp.

USFWS (U.S. Fish and Wildlife Service). 2005. Rangewide Status Review of Ute Ladies'-Tresses (Spiranthes diluvialis). Prepared for the USFWS and Central Utah Water Conservancy District. Prepared by Water Fertig, Rick Black, and Paige Wolken.

USFWS (U.S. Fish and Wildlife Service). 2007. Recovery Plan for Silene spaldingii (Spalding's Catchfly). U.S. Fish and Wildlife Service, Portland, Oregon. xiii+ 187 pages.

USFWS (U.S. Fish and Wildlife Service). 2008. Draft Status Review for Mirabilis macfarlanei (MacFarlane's four o'clock) (draft status review). Snake River Fish and Wildlife Office, Boise, Idaho. Dated September 10, 2008. 57 pages.

USFWS (U.S. Fish and Wildlife Service). 2009. Macfarlane's four-o'clock (Mirabilis macfarlanei) 5 year Review Summary and Evaluation. Snake River Fish and Wildlife Office, Boise, Idaho. June 2009, 26 pages.

USFWS (U.S. Fish and Wildlife Service). 2010. 2010 Protocol for Surveying Proposed Management Activities that May Impact Northern Spotted Owls. Endorsed by the USFWS, February 18, 2010. http://www.fws.gov/arcata/es/birds/NSO/documents/2010%20Northern%20Spotted%20Owl%20Survey%20Protocol-signed%20copy.pdf

USFWS (U.S. Fish and Wildlife Service). 2010b. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp. http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf

Verts, B.J. and l.N. Carraway. 1998. Land mammals of Oregon. University of California Press. Berkley, California. 668 pp.

WDNR (Washington Department of Natural Resources). 1997. Final habitat conservation plan, September 1997. Washington Department of Natural Resources, Olympia, WA.

Wentworth, J.B. 1998. *Castilleja levisecta*, a threatened South Puget Sound prairie species. Pages 101-104 in P. Dunn and K. Ewing (eds.), Ecology and Conservation of the South Puget Sound Prairie Landscape. The Nature Conservancy, Seattle, Washington.

Wentworth, J.B. 2000. The demography and population dynamics of Castilleja levisecta, a federally threatened perennial of Puget Sound grasslands. In: Reichard, S.H.; Dunwiddie, P.W.; Gamon, J.G.; Kruckeberg, A.R.; Salstrom, D.L., editors. Conservation of Washington's Rare Plants and Ecosystems. p 49-51.

Young, S.P. and E.A. Goldman. 1944. The wolves of North America. Am. Wildlife. Inst., Washington, D.C. 385 pp.